125 Series
Wi125 Receiver
User Manual

Issue: R02

Available at Digi-Key
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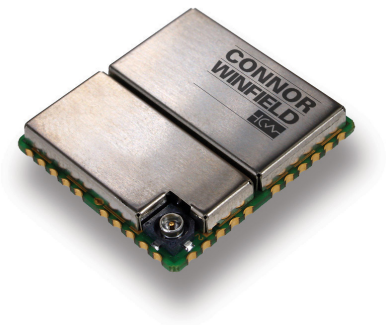

Bulletin	**SG172**
Revision	**03**
Date	**20 Oct 2011**

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1. DESCRIPTION

1.1 Introduction

The 125 Series Wi125 is a small OEM surface mount GPS module specifically designed for use in synchronization and timing in WiMax applications. This compact module has an on-board programmable NCO oscillator that outputs a synthesized frequency up to 30 MHz that is steered by a GPS receiver. The self-survey mode of operation allows the receiver to enter a position hold mode allowing accurate timing to be continued with only one satellite being tracked.

Additionally, the Wi125 has phase alignment of 1 PPS/10 MHz with a very stable holdover. The 1 PPS/10 MHz outputs maintain phase alignment with holdover being base only on the local oscillator, dismissing spurious GPS measurements during re-acquisition. When the receiver regains GPS lock after a period of holdover, the 1PPS and 10 MHz outputs maintain phase alignment and are offset in frequency at the maximum rate of 100 ppb until the 1 PPS aligns with that of the GPS solution. This slow recovery from holdover allows for uninterrupted operation of the WiMax base station.

The Wi125 has a highly accurate output frequency, which can achieve full PRC MTIE performance. Additionally it can track satellites and provide GPS synchronization in weak signal areas including indoor applications, reducing the need for high antenna placement.

The Wi125 is an exceptionally small surface mount package with a highly integrated architecture that requires a minimum of external components allowing easy integration into host systems.

Key features include:

- 1PPS/ 10 MHz Phase alignment
- Stable Holdover
- Holdover Recovery
- 1 PPS & NCO Frequency Output
- GPS/UTC time/scale synchronization to 25 ns RMS
- Stable proven design with long term availability and multi-year support
- 12 channel hardware correlator processor design
- OEM SM footprint 25 x 27 mm
- Automatic entry into holdover
- Loss-of-lock and entry-into-holdover indication

This document provides information on the Hardware and Software elements of the Wi125.

Key information includes:

- Specification
- Physical Characteristics
  - Wi125 Dimensions, castellation information
  - Solder Pad and placement information
- Signal Descriptions
- Features
- Application Information

The Wi125 is available in a number of standard software builds, depending on the application for which it is to be used. In special cases, the Wi125 may be supplied with a slightly different hardware build. The specifications in this manual refer to the standard builds.

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1. DESCRIPTION continued

1.2 Global Positioning System (GPS)

The Global Positioning System (GPS) is a military satellite based navigation system developed by the U.S. Department of Defence, which is made freely available to civil users.

Civilian use of GPS is made available at the user's own risk, subject to the prevailing DoD policy or limitations, and to individuals understanding of how to use the GPS.

In today's satellite constellation there are a minimum of 24 operational satellites (plus several operational spares) in 6 orbital planes, at an altitude of about 22,000 km. The GPS system can give accurate 3-D position, velocity, time, and frequency, 24 hours a day, anywhere around the world.

GPS satellites transmit a code for timing purposes, and also a 'Navigation message', which includes their exact orbital location and system integrity data. Receivers use this information, together with data from their internal almanacs, to precisely establish the satellite location. The receiver determines position by measuring the time taken for these signals to arrive. At least three satellites are required to determine latitude and longitude if your altitude is known (e.g. a ship at sea), and at least a fourth to obtain a 3-D fix.

1.3 GPS Positioning and Navigation

The Wi125 Receiver needs to be able to see at least 4 satellite vehicles (SV's) to obtain an accurate 3-D position fix. When travelling in a valley or built-up area, or under heavy tree cover, you will experience difficulty acquiring and maintaining a coherent satellite lock. Complete satellite lock may be lost, or only enough satellites (3) tracked to be able to compute a 2-D position fix or even a poor 3D fix due to insufficient satellite geometry (i.e. poor DOP). Inside a building or beneath a bridge, it probably will not be possible to update a position fix. The Receiver can operate in 2-D mode if it goes down to seeing only 3 satellites by assuming its height remains constant. But this assumption can lead to large errors, especially when a change in height does occur. A 2-D position fix is not to be considered a good or accurate fix; it is simply "better than nothing".

The receiver's antenna must have a clear view of the sky to acquire satellite lock. Remember, it is the location of the antenna that will be given as the position fix. If the antenna is mounted on a vehicle, survey pole, or backpack, allowance for this must be made when using the solution.

To measure the range from the satellite to the receiver, two criteria are required: signal transmission time, and signal reception time. All GPS satellites have several atomic clocks that keep precise time and these are used to time-tag the message (i.e. code the transmission time onto the signal) and to control the transmission sequence of the coded signal. The receiver has an internal clock to precisely identify the arrival time of the signal. Transit speed of the signal is a known constant (the speed of light), therefore: time x speed of light = distance.

Once the receiver calculates the range to a satellite, it knows that it lies somewhere on an imaginary sphere whose radius is equal to this range. If a second satellite is then found, a second sphere can again be calculated from this range information. The receiver will now know that it lies somewhere on the circle of points produced where these two spheres intersect.

When a third satellite is detected and a range determined, a third sphere would intersect the area formed by the other two. This intersection occurs at two points. The correct point is apparent to the user, who will at least have a very rough idea of position. A fourth satellite is then used to synchronize the receiver clock to the satellite clocks.

In practice, just 4 satellite measurements are sufficient for the receiver to determine a position, as one of the two points will be unrealistic (possibly many kilometers out into space).

This assumes the satellite and receiver timing is identical. In reality, when the Wi125 Receiver compares the incoming signal with its own internal copy of the code and clock, the two will no longer be synchronized. Timing error in the satellite clocks, the Receiver, and other anomalies, mean that the measurement of the signals transit time is in error. This effectively, is a constant for all satellites, since each measurement is made simultaneously on parallel tracking channels. Because of this, the resulting ranges calculated are known as "pseudo-ranges".

To overcome these errors, the Wi125 Receiver then matches or "skews" its own code to become synchronous with the satellite signal. This is repeated for all satellites in turn, thus measuring the relative transit times of individual signals. By accurately knowing all satellite positions, and measuring the signal transit times, the user's position can be accurately determined.

Utilizing its considerable processing power, the Wi125 Receiver rapidly updates these calculations from satellite data to provide a real time position fix. Memory options allow storage of navigation and position data for subsequent post-processing or post-mission analysis, all within a single unit.

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1.4 Standard Positioning Service (SPS)

Civil users worldwide are able to use the SPS without restriction or charge.

Dilution Of Precision (DOP) is a measure of the satellite geometry, and is an indicator of the potential quality of the solutions. The lower the numerical value, the better the potential accuracy (for example, a PDOP below 3 indicates good satellite geometry). For 3-D positioning, fluctuations in DOP can be harmful to the solution, especially in Kinematic/Dynamic modes.

The following DOP terms are computed by Wi125:

HDOP	Horizontal Dilution of Precision	(Latitude, Longitude)
VDOP	Vertical Dilution of Precision	(Height)
TDOP	Time Dilution of Precision	(Timing errors)
PDOP	Position Dilution of Precision	(3-D positioning)
GDOP	Geometric Dilution of Precision	(3-D position & Time)

Estimated accuracy = DOP x measurement accuracy

While each of these terms can be individually computed, they are formed from co-variances, and are not independent of each other. For example, a high TDOP will cause receiver clock errors that will eventually result in increased position errors.

Horizontal accuracy figure of 95% is the equivalent to 2RMS (twice root-mean-square), or twice the standard deviation radial error.

Similarly, for vertical and time errors, a figure of 95% is the value of 2 standard deviations of vertical or time error.

- Root-mean-square (RMS) error is the value of one standard deviation (67%) of error.
- Circular Error Probability (CEP) is the value of the radius of a circle, centred at a position containing 50% of the position estimates.
- Spherical Error Probability (SEP) is the spherical equivalent of CEP, which is centred at a position containing 50% of the position estimates.

CEP and SEP are not affected by large errors, which could make the values an overly optimistic measurement. These probability statistics are not suitable for use in a high accuracy positioning system. The Wi125 reports all accuracies in the form of a standard deviation (RMS) value.

1.5 Precise Positioning Service (PPS)

This service is only available to authorized users with cryptographic equipment and special receivers. Access is limited to the U.S. and allied military, U.S. Government agencies, and selected civil users specifically approved by the U.S. Government.

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2. SPECIFICATION

2.1 Performance

Wi125 GPS RECEIVER SPECIFICATIONS[1]

Physical	Module dimensions	25mm (D) x 27mm (W) x 4.2mm (H)
	Supply voltages	3V3 (Digital I/O), 3V3 (RF), 1V8 (Core option), 3V (Standby Battery)
	Operating Temp	-30°C to +80°C [2]
	Storage Temp	-40°C to +85°C [2]
	Humidity	5% to 95% non-condensing
	Max Velocity / Altitude	515ms^{-1} / 18,000m (increased rating version available subject to export license)
	Max Acceleration / Jerk	4g / 1gs^{-1} (sustained for less than 5 seconds)
Sensitivity	Acquisition with network assist	-155dBm
	Tracking	-156dBm
	Acquisition Stand Alone	-143dBm
Acquisition Time	Hot Start with network assist	Outdoor: <2s Indoor (-148dBm): <5s
	Stand Alone (Outdoor)	Cold: <45s Warm: <38s Hot: <5s Re-acquisition: <1s (90% confidence)
Accuracy	Position: Outdoor / Indoor	<5m rms / <50m rms
	Velocity	<0.05ms^{-1}
	Latency	<200ms
	Raw Measurement Accuracy	Pseudorange <0.3m rms, Carrier phase <5mm rms
	Tracking	Code and carrier coherent
Power	1 fix per second	0.6W typically
	Coma Mode Current (RF3V3+DIG3V3)	<10mA
	Standby Current (VBATT)	1.5µA
Interfaces	Serial	3 UART ports, CMOS levels
	Multi function I/O	1PPS Frequency Output available on GPIO [0] Event Counter/Timer Input Up to 4 x GPIO (multi-function) 2 x LED Status Drive I^{2}C, External Clock (on special build)
	Protocols	Network Assist, NMEA 0183, Proprietary ASCII and binary message formats
	1pps Timing Output	25nS rms accuracy, <5nS resolution, Factory customizable pulse width
	Event Input	30nS rms accuracy, <10nS resolution
	Frequency Output (GPIO [0])	0 MHz to 20 MHz (Wi125-NAV) 10 Hz to 30 MHz (Wi125-TIM)
	Receiver Type	12 parallel channel x 32 taps up to 32 point FFT. Channels, taps and FFT can be switched off to minimize power or simulate simpler designs.
General	Processor	ARM 966E-S on a 0.18 micron process at up to 120 MHz.

Note: 1. The features listed above may require specific software builds and may not all be available in the initial release.
2. Please contact factory for other temperature options.

Table 1 Wi125 Specification

2.2 Recommended Ratings

Symbol	Parameter	Min	Max	Units
RF_3V3	RF Supply Voltage	+3.0	+3.6	Volts
DIG_3V3	Digital Supply Voltage	+3.0	+3.6	Volts
DIG_1V8	Digital Supply Voltage	+1.65	+1.95	Volts
VBATT	Battery Backup Voltage	+2.7	+3.5	Volts
ANT_SUPPLY	Antenna Supply Voltage	+3.0	+12	Volts

Table 2 Absolute Maximum Ratings

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2.3 Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Units
RF_3V3	RF Supply Voltage	-0.3	+6.5	Volts
DIG_1V8	Digital Supply Voltage	-0.3	+2.0	Volts
DIG_3V3	Digital Supply Voltage	-0.3	+3.7	Volts
VBATT	Battery Backup Voltage	-0.5	+7.0	Volts
ANT_SUPPLY	Antenna Supply Voltage	-15	+15	Volts
DIG_SIG_IN	Any Digital Input Signal	-0.3	+5.5	Volts
RF_IN	RF Input	-15	+15	Volts
TSTORE	Storage temperature	-40	+85	°C
IOUT	Digital Signal Output Current	-6	+6	mA

Table 3 Absolute Maximum Ratings

2.4 Block Diagram

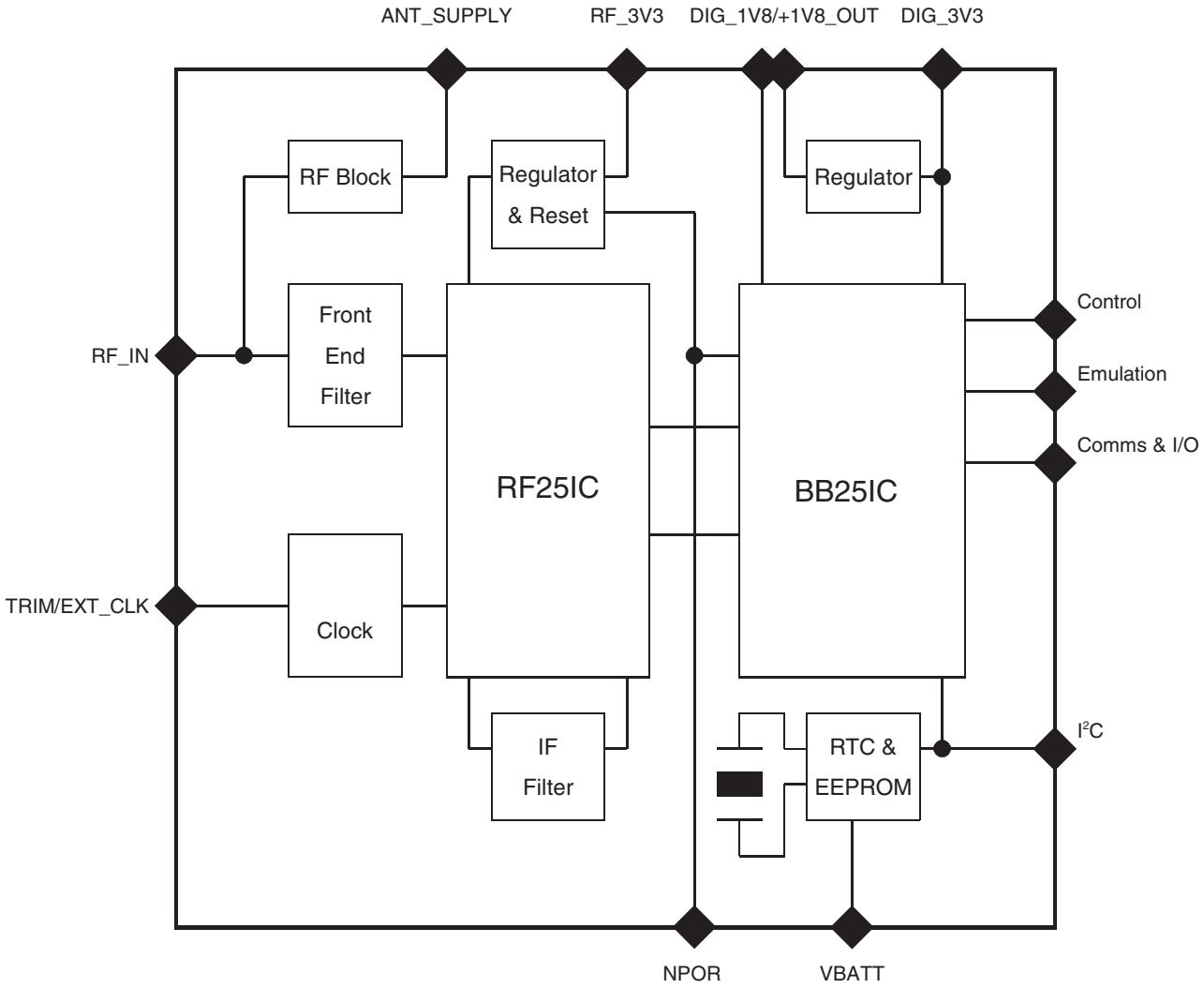

Figure 1 Block Diagram

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3. PHYSICAL CHARACTERISTICS

The Wi125 is a multi-chip module (MCM) built on an FR4 fiberglass PCB. All digital and power connections to the MCM are via castellations on the 25 x 27 mm PCB. The RF connection is via castellations or an RF connector. The general arrangement of the Wi125 is shown in the diagram below. Dimensions are in mm (inches/1000).

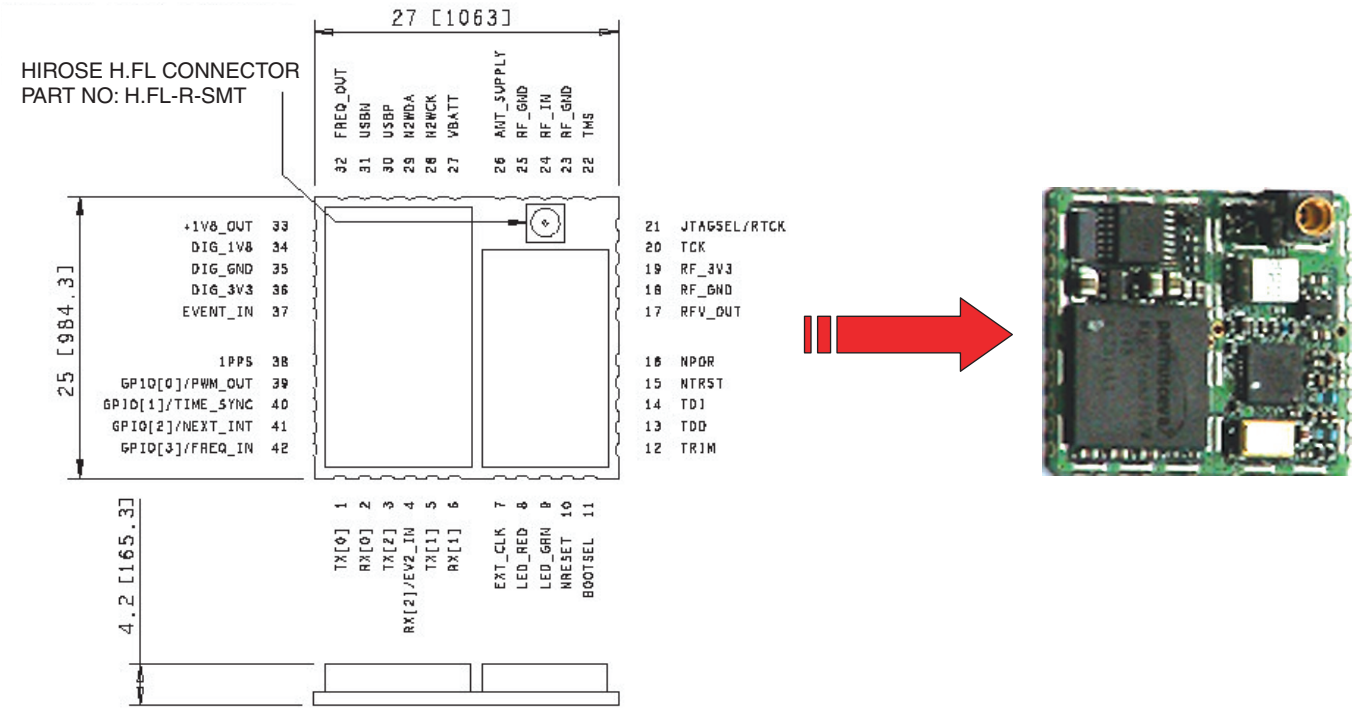

Figure 2 Wi125 Form and Size

3.1 Physical Interface Details

The interface to the Wi125 is via 1mm castellation on a 2mm pitch. There are 42 connections in all. There is also an RF connector for connecting to the GPS antenna. The details of the interface connections are given below.

Pin	Function	Pin	Function
1	TX [0]	22	TMS
2	RX [0]	23	RF_GND
3	TX [2]	24	RF_IN
4	RX [2]/EV2_IN	25	RF_GND
5	TX [1]	26	ANT_SUPPLY
6	RX [1]	27	VBATT
7	EXT_CLK	28	N2WCK
8	LED_RED	29	N2WDA
9	LED_GRN	30	USBP
10	NRESET	31	USBN
11	BOOTSEL	32	FREQ_OUT [3]
12	TRIM	33	+1V8_OUT
13	TDO	34	DIG_1V8
14	TDI	35	DIG_GND
15	NTRST	36	DIG_3V3
16	NPOR	37	EVENT_IN
17	RFV_OUT	38	1PPS
18	RF_GND	39	GPIO [0]/PWM_OUT
19	RF_3V3	40	GPIO [1]/TIME_SYNC
20	TCK	41	GPIO [2]/NEXT_INT
21	JTAGSEL/RTCK	42	GPIO [3]/FREQ_IN

Note: 3. Frequency Output is available on pin 32 (FREQ_OUT) with custom software only.

Table 4 Wi125 Signal List

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3.2 MCM Dimensions

The figure below provides the dimensions of the positioning of the Wi125 castellations. Dimensions are in mm (inches/1000).

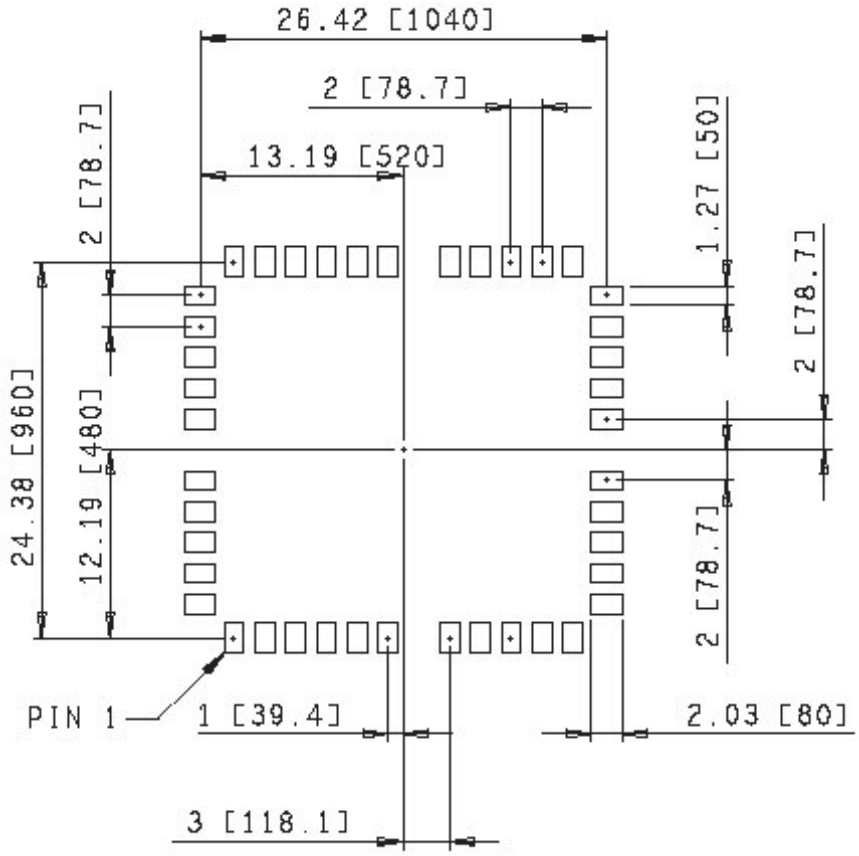

Figure 3 MCM Dimensions

3.3 Solder Pad Size and Placement

It is recommended that the footprint of the solder pad under each castellation be 2mm x 1mm, centered on the nominal center point of the radius of the castellation. The castellations are gold plated and so are lead free. Note that if the RF_IN **connector** is being used, there should not be a pad or solder resist under the RF_IN castellation. If the RF_IN **castellation** is to be used, the pad should be shortened by 0.5mm underneath the Wi125 and standard RF design practices must be observed. The diagram below shows the placement of the pads under the castellations.

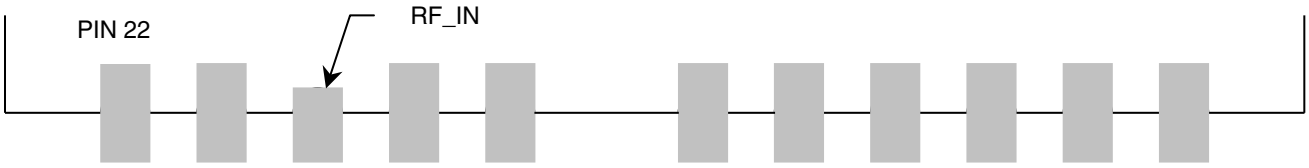

Figure 4 Solder Pad Size and Placement

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4. SIGNAL DESCRIPTION

The signals on the Wi125 are described in the table below. All Test, Control and I/O ports are CMOS 3.3V compatible unless specified otherwise.

4.1 Power Signals

RF_3V3	Type: Power	Direction: Input	Pin: 19
	The RF supply input. This 3.3V ± 10% input supplies the 3.0V LDO regulator in the RF section of the Wi125. It is important that this supply is well filtered with no more that 50mV peak to peak noise with respect to RF_GND.		
RF_GND	Type: Power	Direction: Input/Output	Pins: 18, 23, 25
	The RF input ground connect to common ground. This is the return path for the RF_3V3 supply and the ground for the antenna feed. The RF_GND must be tied to the DIG_GND externally to the Wi125.		
RFV_OUT	Type: Power	Direction: Output	Pin: 17
	The output from the LDO regulator (3.0V) that is powered by the RF_3V3 signal. This supplies the power to the RF subsystem of the Wi125. This may also be used to power external RF components but care must be taken not to inject noise onto this signal. No more than an additional 30mA may be taken from this signal by external circuitry.		
ANT_SUPPLY	Type: Power	Direction: Input	Pin: 26
	The antenna supply voltage. This can be used to supply power to the RF_IN signal, for use by an active antenna. The maximum voltage should not exceed ±15V and the current should be limited to 50mA to prevent damage to the Wi125.		
DIG_3V3	Type: Power	Direction: Input	Pin: 36
	The digital supply input. This 3.3V ± 10% input supplies the I/O ring of the BB25IC chip and the LDO regulator in the digital section of the Wi125. It is important that this supply is well filtered with no more that 50mV peak to peak noise with respect to DIG_GND.		
DIG_1V8	Type: Power	Direction: Input	Pin: 34
	The 1.8V ± 5% digital core supply for the BB25IC. This is normally connected directly to the +1V8_OUT signal. However, if an external 1.8V ± 5% is available, a lower overall system power consumption may be achieved by using an external supply.		
+1V8_OUT	Type: Power	Direction: Output	Pin: 33
	The 1.8V output from the LDO regulator that is powered by the DIG_3V3 signal. Normally, this is connected to the DIG_1V8 signal. This loops back the regulated 1.8V to run the processor core. If not connected the core will not run. This may also be used to power external logic but care must be taken not to inject noise onto this signal. No more than an additional 50mA may be taken from this signal by external logic.		
DIG_GND	Type: Power	Direction: Input/Output	Pin: 35
	The digital ground. This is the return path for the DIG_3V3 supply and the ground reference for all the digital I/O. The DIG_GND must be tied to the RF_GND externally to the Wi125.		
VBATT	Type: Power	Direction: Input/Output	Pin: 27
	The battery backup supply. The Wi125 has an on board Real Time Clock (RTC). This is powered from the VBATT signal. A supply of typically 3V (greater than 2.5V and less than DIG_3V3) should be applied to this signal. This signal can be left floating if not required. The input has a blocking diode and so rechargeable batteries need an external charging circuit. Typically, a 1K resister in series with this signal and the external battery will provide an easy method of measuring the current consumption from VBATT during test.		

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4.2 RF Signals

RF_IN	Type: RF	Direction: Input	Pin: 24
	The RF input signal attaches to the GPS antenna. Standard RF design rules must be used when tracking to this signal. This signal has an RF blocked connection to the ANT_SUPPLY signal. This is the same signal presented on the RF connector on the Wi125. Only one antenna connection should be made. If the RF connector is to be used, then there should be no connection, even an unconnected pad, to this castellation.		
TRIM	Type: RF	Direction: Input	Pin: 12
	This signal trims the output frequency of the VCTCXO. This signal is normally left open. When floating, this signal is biased to the control voltage of the VCTCXO. Any noise injected into this signal will severely compromise the performance of the Wi125. This signal should only be used in conjunction with specific application notes.		
EXT_CLK	Type: RF	Direction: Input	Pin: 7
	This input is the external clock input. This signal is to be used only in special builds of the Wi125 that are not fitted with an internal VCTCXO. For the normal build, containing the VCTCXO, do not connect this input. The external clock is a 20 MHz clipped sinewave input with an amplitude between 1V and 3V peak to peak. The return path for this signal is RF_GND.		

4.3 Emulation/Test Signals

TDI	Type: Test	Direction: Input	Pin: 14
	The Test Data In signal is the standard JTAG test data input. The signal return path is DIG_GND.		
TDO	Type: Test	Direction: Output	Pin: 13
	The Test Data Out signal is the standard JTAG test data output. The signal return path is DIG_GND.		
TCK	Type: Test	Direction: Input	Pin: 20
	The Test Clock signal is the standard JTAG test clock input. The signal return path is DIG_GND.		
TMS	Type: Test	Direction: Input	Pin: 22
	The Test Mode Select signal is the standard JTAG test mode input. The signal return path is DIG_GND.		
JTAGSEL/RTCK	Type: Test	Direction: Input/Output	Pin: 21
	This is a dual function signal. When the NPOR signal is asserted (low), this signal is an input and selects the function of the JTAG interface. When high, JTAG emulation into the embedded ARM9 processor is selected. When low, the BB25IC chip boundary scan mode is selected. The value on this signal is latched when NPOR de-asserts (goes high). When NPOR is de asserted (high) and the JTAG emulation mode has been latched, this signal provides the return clock to the ARM Multi-ICE. Because the ARM9 functions off a single clock domain, the TCK has to be internally synchronized in the ARM9. This can cause a variable length delay in the validity of the TDO signal. The RTCK is a synchronized version of the TCK signal. The Multi-ICE uses the RTCK output signal to indicate when the TDO signal is valid. The signal return path is DIG_GND. Pull it to VCC (DIG_3V3) through a 1K resistor for normal operation.		
NTRST	Type: Test	Direction: Input	Pin: 15
	The Test Reset signal. This is the active low JTAG test reset signal. The signal return path is DIG_GND. Pull it to ground through a 1K resistor for normal operation.		

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4.4 Control Signals

NPOR	Type: Control Direction: Input/Output	Pin: 16
	The Power On Reset signal. This active low, open collector signal is the master reset for the Wi125. This should be driven with an open collector reset circuit for a minimum of 100ms. An external pull-up is not required if the 100K internal pull-up is sufficient. The Wi125 can be held in reset by asserting this signal. The signal can be used to reset external circuitry, but care must be taken to ensure no DC current is drawn from this signal as the internal pull-up resistor value is 100K.	
NRESET	Type: Control Direction: Input/Output	Pin: 10
	The system reset signal. This active low, open collector signal is generated by the BB25IC chip in response to the assertion of the NPOR. It may also be driven to reset the ARM9 processor in the BB25IC without completely re-initializing the chip.	
BOOTSEL	Type: Control Direction: Input	Pin: 11
	The boot select signal. The BB25IC has four boot up modes, but only two are supported by the Wi125. This signal is sampled when the NPOR is de-asserted. If the BOOTSEL signal is high or left floating, then the Wi125 boots from its on-chip FLASH memory. If the BOOTSEL signal is pulled low, the Wi125 boots from its on-chip ROM.	

4.5 I/O Signals

TX [0]	Type: I/O	Direction: Output	Pin: 1
	The transmit signal for UART 1 is a standard UART output signal. The signal return path is DIG_GND.		
TX [1]	Type: I/O	Direction: Output	Pin: 5
	The transmit signal for UART 2 is a standard UART output signal. The signal return path is DIG_GND.		
TX [2]	Type: I/O	Direction: Output	Pin: 3
	The transmit signal for UART 3 is a standard UART output signal. The signal return path is DIG_GND.		
RX [0]	Type: I/O	Direction: Input	Pin: 2
	The receive signal for UART 1 is a standard UART input signal. The signal return path is DIG_GND. [6]		
RX [1]	Type: I/O	Direction: Input	Pin: 6
	The receive signal for UART 2 is a standard UART input signal. The signal return path is DIG_GND. [6]		
RX [2]/EV2_IN	Type: I/O	Direction: Input	Pin: 4
	This is a dual mode signal. Normally, this is the receive signal for UART 3, a standard UART receive signal. Under software control, it can also be used as general purpose I/O or to detect events. It can be used to detect the timing of the leading edge of the start bit of the incoming data stream. The signal return path is DIG_GND. [6]		
FREQ_OUT	Type: I/O	Direction: Input/Output	Pin: 32
	Optional frequency output signal. It is NOT the same signal as Pin 39. This signal is turned off by default. This is a complex signal which under software can provide any of either an NCO generated output frequency, a PWM signal, a GPS aligned EPOCH pulse or general purpose I/O signal. The signal return path is DIG_GND.		
1PPS	Type: I/O	Direction: Input/Output	Pin: 38
	The 1 pulse per second signal is normally a 1 pulse aligned with GPS time, but can under software control also provide general purpose I/O or an additional even input. The pulse width of the 1PPS is software selectable with a default of 100µs. The signal return path is DIG_GND.		

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EVENT_IN	Type: I/O	Direction: Input/Output	Pin: 37
	The Event Input Signal with internal connection to Pin 39 (GPIO[1] / Time Sync) allows phase measurement of the Frequency Output. The signal return path is DIG_GND.		
N2WCK	Type: I/O	Direction: Input/Output	Pin: 28
	The NavSync 2 Wire Clock signal is the open collector I²C compatible clock signal for the 2 wire serial interface. The signal return path is DIG_GND. [4]		
N2WDA	Type: I/O	Direction: Input/Output	Pin: 29
	The NavSync 2 Wire Data signal is the open collector I²C compatible data signal for the 2 wire serial interface. The signal return path is DIG_GND. [4]		
USBP	Type: I/O	Direction: Input/Output	Pin: 30
	The positive USB signal. The signal return path is DIG_GND. [5]		
USBN	Type: I/O	Direction: Input/Output	Pin: 31
	The negative USB signal. The signal return path is DIG_GND. [5]		
LED_RED	Type: I/O	Direction: Output	Pin: 8
	This is a dual function signal. Normally this signal is used to drive a red LED. Standard software builds use this signal to indicate GPS status. In special software builds, this signal can be used as GPIO. This signal has a 3.3V CMOS drive. A series limiting resistor is required to limit output current to ±5mA (typically 270 ohms). The signal return path is DIG_GND.		
LED_GRN	Type: I/O	Direction: Output	Pin: 9
	This is a dual function signal. Normally this signal is used to drive a green LED. Standard software builds use this signal to indicate GPS status. In special software builds, this signal can be used as GPIO. This signal has a 3.3V CMOS drive. A series limiting resistor is required to limit output current to ±5mA (typically 270 ohms). The signal return path is DIG_GND.		
GPIO[0]/PWM	Type: I/O	Direction: Input/Output	Pin: 39
	Normally the GPIO[0]/PWM output provides a Frequency Output that defaults to 10 MHz, and is user configurable from 10 Hz to 30 MHz signal. The output is enabled on power-up and is steered by the GPS solution. Custom software versions can also configure this pin for general I/O, PWM or EPOCH output. The signal return path is DIG_GND.		
GPIO[1]/TIME_SYNC	Type: I/O	Direction: Input/Output	Pin: 40
	The GPIO[1]/TIME_SYNC pin provides a synchronization pulse generated by the onboard RTC. Custom software versions can also configure this pin for general purpose I/O, or an additional PPS output. The signal return path is DIG_GND.		
GPIO[2]/NEXT_INT	Type: I/O	Direction: Input/Output	Pin: 41
	The GPIO[2]/NEXT_INT output provides an active high status indicator for the Frequency Output available on pin 39 (GPIO[0]/PWM). Custom software versions can also configure this pin for general purpose I/O. The signal return path is DIG_GND.		
GPIO[3]/FREQ_IN	Type: I/O	Direction: Input/Output	Pin: 42
	The GPIO[3]/FREQ_IN output provides an active high status 3D fix indicator. This indicator can also be used to determine the validity of the pin 38 (1PPS) output. The signal return path is DIG_GND.		

Notes

4. Accessible with custom software only.

5. USB is not supported in the current software build. Leave these two pins unconnected.

6. After NPOR is de-asserted, no serial data should be sent for 3 seconds while the serial ports are initialized.

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5. FEATURES

5.1 Power on Reset

The power on reset for the Wi125 is generated on-board by the regulator in the RF section from the RF_3V3 signal. The RF_3V3 signal must be applied to the Wi125 at the same time as the DIG_3V3, if the on-board power on reset is to be used. If an external source of reset is to be applied to the NPOR signal after both the RF_3V3 and the DIG_3V3 signals are valid, this restriction does not apply.

5.2 Time Transfer

In order to aid time transfer between fixes during which the Wi125 has been unable to maintain an accurate perception of time (eg. In deep sleep or powered down states), the on-board RTC can be set to provide a signal derived from the 32.768Hz crystal.

5.3 Wi125 Embedded Identification

The hardware version number is hard coded onto the Wi125; firmware also contains a version number allowing for easy identification of the hardware and software version in embedded applications.

5.4 Stationary Timing Receiver

The Wi125 operates in a survey and position hold mode which allows increased accuracy for timing applications. The Wi125's default dynamics setting is 1 and changes to 0 after a 10-minute position survey is completed. Refer to Section 8.3.6 for more details on the dynamics setting. During operation, the receiver antenna must remain stationary.

5.5 Frequency Output and 1PPS Phase Alignment

The Wi125 maintains phase alignment between the Frequency Output (up to 10 MHz) and 1pps allowing the Frequency Output to be used as a time reference as well as a frequency reference. After an initial GPS fix, the phase alignment is maintained during holdover, when the GPS fix is lost. During recovery from holdover, when the GPS fix regained, the Frequency Output and 1PPS walk back to the GPS solution position at a maximum rate of 100 ns/s while maintaining phase alignment between the two outputs.

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6. OPERATING MODES

6.1 Stand Alone Operation

For stand alone operation the receiver will perform cold starts with no prior knowledge of position or GPS satellite data such as almanacs and ephemeris provided the antenna has a clear view of the sky to provide signal strengths of 35dB or higher. The receiver should be allowed to track satellites for a minimum period of 15 minutes to ensure all almanac information has been received. The GPS data is stored in the EEPROM memory fitted to the Wi125. Once the receiver has been initialized and has current almanac and ephemeris data it may then be taken indoors for test with low level signals.

Hot starts (current ephemeris data held in EEPROM) can be performed with low level signals (indoors).

6.2 Network Assist Operation

For network assist operation the NavSync Network Assistance Base Station must be connected to an external antenna and be tracking all satellites in view. The network assistance data connection is provided by an RS232 link between port 3 on the network assistance base station and port 3 on the Wi125.

With the network assistance base station connected the development system can be started in indoor or outdoor environments.

For more information on the Network Assistance data format please refer to section 8.4.

7. POWER MANAGEMENT

The Wi125 GPS receiver is a low power module consuming less than 0.6W typically for a 1Hz update of position. The receiver contains software to dynamically reduce power consumption wherever possible. Where channels and taps are not needed they are switched off. When the processor is not required it is put into a halt until interrupt state and the chips clock system is geared down to reduce power consumption. All of these things are performed automatically without any user configuration. If further power saving is required the receiver can be reprogrammed with smaller GPS configurations thereby permanently switching off portions of the GPS hardware and allowing the processor speed to be reduced, thereby saving power.

7.1 Coma Mode

For powered battery application, which needs to reduce the power consumption, it is possible to switch the receiver into Coma mode. This configures the RF front end into sleep mode, switches off internal peripherals and places the processor in a sleep state waiting for an interrupt.

Coma mode is initiated through the COMA serial command, details of which can be found in section 8.3.7.

Care must be taken in the implementation of the Wi125 to ensure power consumption is minimized. All input pins without bias resistors have potential to float mid rail and consume power during coma mode. Three GPIO pins default as inputs and do not have bias resistors. GPIO [1]/TIME_SYNC can be factory programmed to provide either an additional PPS output or a time synchronization input to the GPS engine. GPIO [2]/NEXT_INT can provide an interrupt event from an active low external input. GPIO [3]/FREQ_IN provide a frequency counter input. Care must be taken to ensure that the pins have external bias resistors off board to ensure they are not left floating. It is recommended that all unterminated test, Control and I/O ports are pulled high or low as appropriate (making note of the active state of some ports e.g. BSEL), with typically 100k ohms.

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8. COMMUNICATION PROTOCOLS

Full descriptions of the communications protocols used by the Wi125 can be found in section 8.2 and 8.3.

8.1 Port Configuration

There are three serial ports available on the Wi125. They are three UARTs of the Wi125 receiver. These are configured as follows:

Port	Baud Rate	Function
1	38400	NMEA
2	38400	Debug
3	38400	Network Assistance

Table 6 Port Configurations

All ports are configured as 8 bits, no parity, with no handshaking.

8.2 Output Format

There are two types of messages that can be output from the Wi125 receiver, these are split into NMEA sentences and Debug messages. Both types of outputs are ASCII strings.

8.2.1 NMEA Messages

There are two main types of sentence, 'Approved' and 'Proprietary'. All sentences start with $ delimited with commas and ending with <CR><LF>. Approved sentences are recognized by the first 5 characters after the $, which define both the kind of talker providing the information (2 characters, GP in the case of a GPS), and the type of information (3 characters). Proprietary sentences are indicated by a P following the $, as the first of the 5 characters, the next 3 indicating the manufacturer (from a listing of mnemonic codes), and the 5th character being selected by that manufacturer for the particular sentence structure. Proprietary sentences must conform to the general NMEA structures, but are otherwise undefined outside of the Manufacturers own documentation.

The following Approved messages are available from the Wi125 receiver:

GPGLL - Geographic Position - Latitude longitude
GPGGA - Global Positioning System Fix Data
GPGSA - GNSS DOP and Active Satellites
GPGSV - GNSS Satellites in View
GPRMC - Minimum required sentence
GPVTG - Velocity and track over ground
GPZDA - Date and time
POLYT - Navsync Proprietary time of day message
POLYP - Navsync Proprietary status message
POLYS - Navsync Proprietary satellite status message (GPGGA + GPGSV)
POLYI - Navsync Proprietary net assist information message

Approved NMEA messages

8.2.1.1 GPGLL - Geographic position, Lat/Lon

Latitude and longitude, with time of position fix and status.

$*GPGLL, Latitude, N, Longitude ,E, hhmmss.sss, Status, Mode*cs*

Name	Description
$GPGLL	NMEA sentence header (Position Data)
Latitude	User datum latitude degrees, minutes, decimal minutes format (ddmm.mmmmmm)
N	Hemisphere 'N'= North, or 'S' = South
Longitude	User datum longitude degrees, minutes, decimal minutes format (dddmm.mmmmmm)
E	Longitude Direction 'E'= East, or 'W' = West
hhmmss.sss	UTC Time in hours, minutes, seconds and decimal seconds format.
Status	StatusV=navigation receiver warning, A=data valid
Mode	Mode indicator:A=Valid, Autonomous, D=Valid, Differential, E=Invalid, Estimated, N=Invalid, Not valid
Cs	Message checksum in hexadecimal

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8.2.1.2 GPGGA - GPS fix data

Time and position, together with GPS fixing related data.

$*GPGGA, hhmmss.sss, Latitude, N, Longitude , E, FS, NoSV, HDOP , Altref , M, msl , M, DiffAge , DiffStation*cs*

Name	Description
$GPGGA	NMEA sentence header (Position Data)
hhmmss.sss	UTC Time in hours, minutes, seconds and decimal seconds format.
Latitude	User datum latitude degrees, minutes, decimal minutes format (ddmm.mmmmmm)
N Hemisphere	'N'= North, or 'S' = South
Longitude	User datum longitude degrees, minutes, decimal minutes format (dddmm.mmmmmm)
E	Longitude Direction: 'E'= East, 'W' = West
FS	Fix Status: 0 No fix 1 Standard GPS 2 Differential GPS
NoSv	Number of satellites used in the position solution
HDOP	2-D Horizontal Dilution of Precision (0.00 to 99.99)
AltRef	Altitude (meters) above user datum ellipsoid
M	Units of height (meters)
msl	Mean Sea Level
M	Units of Mean Sea Level (meters)
DiffAge	Age of differential correction
DiffStation	Differential base station ID
cs	Message checksum in hexadecimal

8.2.1.3 GPGSA - GPS DOP and Active satellites

GPS receiver operating mode, satellites used for navigation, and DOP values.

*$GPGSA,Smode,FS,sv,sv,sv,sv,,,,,,,,PDOP,HDOP,VDOP*cs*

Name	Description
$GPGSA	NMEA sentence header (Satellite Data)
Smode	A= Automatic switching 2D/3D M=Manually fixed 2D/3D
FS	Fix Status: 1 No fix 2 2D GPS Fix 3 3D GPS Fix
sv	Satellites in use, null for unused fields (12 available fields)
PDOP	3-D Position Dilution of Precision (0.00 to 99.99)
HDOP	2-D Horizontal Dilution of Precision (0.00 to 99.99)
VDOP	Vertical Dilution of Precision (0.00 to 99.99)
cs	Message checksum in hexadecimal

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8.2.1.4 GPGSV - GPS Satellites in View

The number of satellites in view, together with each PRN, elevation and azimuth, and C/No value. Up to four satellite details are transmitted in one message, with up to three messages used as indicated in the first field.

*$GPGSV, NoMsg, MsgNo, NoSv{,sv,elv,az,cno}{,sv,elv,az,cno….}*cs*

Note: {} designate optional sections that appear only if there is satellite data.

Name	Description
$GPGSV	NMEA sentence header (Satellite Data)
NoMsg	Total number of GPGSV messages being output
MsgNo	Number of this messages
NoSv	Number of satellites in view
sv	Satellites ID
elv	Satellite elevation angle (degrees)
az	Satellite azimuth angle (degrees)
cno	Satellite signal/Noise ration (dB/Hz)
cs	Message checksum in hexadecimal

8.2.1.5 GPRMC - Recommended Minimum data

The 'Recommended Minimum' sentence is defined by NMEA for GPS/Transit system data.

*$GPRMC,hhmmss.sss,status,latitude,N,Hemisphere,longitude,E,spd,cmg,ddmmyy,mv,mvd,Mode*cs*

Name	Description
$GPRMC	NMEA sentence header (Recommended Minimum Sentence)
hhmmss.sss	UTC Time in hours, minutes, seconds.
status	Status:V=navigation receiver warning, A=data valid
Latitude	User datum latitude degrees, minutes, decimal minutes format (ddmm.mmmmmm)
N	Hemisphere: 'N'= North, or 'S' = South
Longitude	User datum longitude degrees, minutes, decimal minutes format (dddmm.mmmmmm)
E	Longitude Direction: 'E'= East, 'W' = West
spd	Speed over ground (knots).
cmg	Course made good
ddmmyy	Date in Day, Month Year format
mv	Magnetic variation
mvd	Magnetic variation direction
Mode	Mode Indicator: D = Valid, Differential, A = Valid, Autonomous, E = Invalid, Estimated, N = Invalid, Not Valid
cs	Message checksum in hexadecimal

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8.2.1.6 GPVTG - Course over ground and Ground speed.

Velocity is given as Course over Ground (COG) and Ground Speed

*$GPVTG,cogt,T,cogm ,M ,knots,N,kph,K,Mode*cs*

Name	Description
$GPVTG	NMEA sentence header (Speed and heading)
cogt	Course over ground (true)
T	True - fixed field
cogm	Course over ground (magnetic)
M	Magnetic - fixed field
knots	Speed over ground (knots)
N	Knots - fixed field
kph	Speed over ground (kph)
K	Kilometers per hour – fixed field
Mode	Mode Indicator:D = Valid, Differential, A = Valid, Autonomous, E = Invalid, Estimated, N = Invalid, Not Valid
cs	Message checksum in hexadecimal

8.2.1.7 GPZDA - UTC Time and Date

This message transfers UTC Time and Date. Since the latency of preparing and transferring the message is variable, and the time does not refer to a particular position fix, the seconds' precision is reduced to 2 decimal places.

*$GPZDA,hhmmss.sss,dd,mm,yyyy,Int,Unsigned*cs*

Name	Description
$GPZDA	NMEA sentence header (Time and Date)
hhmmss.sss	UTC Time in hours, minutes, seconds.
dd	UTC day
mm	UTC month
yyyy	UTC year
Int Unsigned	Local zone hours
Int Unsigned	Local zone minutes
kph	Speed over ground (kph)
K	Kilometers per hour – fixed field
cs	Message checksum in hexadecimal

Proprietary NMEA Messages

8.2.1.8 POLYT - Time of Day

*$POLYT,hhmmss.sss,ddmmyy, UTC_TOW ,week, GPS_TOW ,Clk_B , Clk_D ,PG,LocalTTag,BAcc,TAcc,BLANK*cs*

Name	Description
$POLYT	NavSync Proprietary NMEA sentence header (Position Data)
hhmmss.sss	UTC Time in hours, minutes, seconds and decimal seconds format.
ddmmyy	Date in day, month, year format.
UTC_TOW	UTC Time of Week (seconds with microseconds resolution)
week	GPS week number (continues beyond 1023)
GPS_TOW	GPS Time of Week (seconds with microseconds resolution)
Clk_B	Receiver clock Bias (nanoseconds)
Clk_D	Receiver clock Drift (nanoseconds/second)
PG	1PPS Granularity (nanoseconds)
LocalTTag	Local receiver time-tag since start-up [msec]
BAcc	Bias Accuracy
TAcc	Time Accuracy
cs	Message checksum in hexadecimal

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8.2.1.9 POLYP- Position Data

*$POLYP,hhmmss.sss,Latitude,N,Longitude,E, AltRef ,FS,Hacc,Vacc, SOG , COG , V_vel,ageC,HDOP,VDOP,PDOP,GDOP,TDOP,GU,RU,DR*cs*

Name	Description
$POLYP	NavSync Proprietary NMEA sentence header (Position Data)
hhmmss.sss	UTC Time in hours, minutes, seconds and decimal seconds format.
Latitude	User datum latitude degrees, minutes, decimal minutes format (ddmm.mmmmmm)
N	Hemisphere: 'N'= North, 'S' = South
Longitude	User datum longitude degrees, minutes, decimal minutes format (dddmm.mmmmmm)
E	Longitude Direction: 'E'= East, 'W' = West
AltRef	Altitude (meters) above user datum ellipsoid.
FS	Fix Status: NF = No Fix DR = Predictive Dead Reckoning solution DA = Predictive Dead Reckoning solution with DR aiding G1 = Partial GPS solution with DR aiding G2 = Stand alone 2D solution G3 = Stand alone 3D solution D1 = Partial Differential GPS solution with DR aiding D2 = Differential 2D solution D3 = Differential 3D solution
Hacc	Horizontal (2 sigma) accuracy estimates (0 to 99999 meters)
Vacc	Vertical (2 sigma) accuracy estimates (0 to 99999 meters)
SOG	Speed Over Ground (knots) (0.000 to 999.999 knots)
COG	Course Over Ground (true) in degrees (0.00 to 359.99 degrees)
V_vel	Vertical (positive Up) velocity (m/s) (0.000 to 999.999 m/s)
ageC	Age of most recent DGPS Corrections applied (seconds).(00.00 to 99.99 = none available)
HDOP	2-D Horizontal Dilution of Precision (00.00 to 99.99)
VDOP	Vertical Dilution of Precision (00.00 to 99.99).
PDOP	3-D Position Dilution of Precision (00.00 to 99.99)
TDOP	Time Dilution of Precision (00.00 to 99.99)
GU	Number of GPS satellites used in the navigation solution
RU	Number of GLONASS satellites used in the navigation solution
DR	Dead Reckoning aiding status bits (in ASCII Hex) bit 0 Altitude Position Aiding applied bit 1 Vertical Velocity Aiding applied bit 2 (GPS-GLONASS) time difference aiding applied bit 3 External Distance travelled input used bit 4 External Speed input used bit 5 External Track input used bit 6 External Delta -Track input used bit 7,8 Reserved for future use
cs	Message checksum in hexadecimal

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8.2.1.10 POLYS - Satellite Status

*$POLYS,GT{,ID,s,AZM,EL,SN,LK}{,ID,s,AZM,EL,SN,LK}{,ID,s,AZM,EL,SN,LK}

8. Communication Protocols continued

8.2.2 Debug Messages

The debug messages were implemented for internal testing purposes, but may be useful for advanced users requiring more information than is available through the standard NMEA output messages.

The messages were designed to be displayed on a terminal, which recognizes the HOME character (ASCII 11) and clear screen (ASCII 12). This mode is supported in NS3Kview by switching the NMEA monitor window of NS3Kview to debug mode, see section 10.3 in NS3Kview User Manual. To display information on a terminal use a VT-100 emulation, this will allow the information to be display static on the screen, rather than being scrolling text.

Each information page can be commanded by sending $x<cr><lf>, where x is the page number. A list of the most commonly used debug pages is listed by sending $1<cr><lf> as shown below:

```
Screens 11,52

NV_RAM = 4980
NA_RAM = 3288
Stacks = 3968
dsp_SD = 12240
```

The above example shows that debug screens 11 and 52 are available. The additional information details the amount of memory used within the systems for Non volatile memory, Network Assistance data, Stacks and DSP data memory.

To display any of the available debug screens simply type $x<cr>, where x is the screen number e.g. $11<cr>

Each of the above information pages is detailed below. The debug information is not limited to the above list and special debug pages may be available depending on the software within the receiver. Any additional pages specific to software versions are not described in this manual.

8.2.3.1 Navigation and Timing Summary ($11)

```
Navigation Summary Page 12x32x32x16       Wi125 1.741 May 10 2004 15:03:41
Time 140533.70   3840 1270 137133.708 1  15   0 -569556.04 -675.87
Geod  52 14 58.28304 N  1 9 21.20855 E  209.19 161.75  s----------
Local   921.146  -15325.118    83.187  0.009  0.007 193.89  0.015
Acc  5 5 1 0  34  101  106  95  95 0.24 0.15  1.70  2.43  2.97
ExtT 0  0.000  0.000  0  0.000000  0.000  0  0.000  0.000
APA  0  0.000  0.000  0.000 VVA 0  0.000  0.000  0.000 dy 2 T0   0
Sigs  1.569  1.235  0.000  0.100  0.003  0.006 EC  0  0  0 JN 0
VarF  0.011  0.007  0.000  0.072  0.002  0.007 S 1 I 1.024 cr 0 ts 0
Reset 0 93  48     13 0 QB 022    13 ST 1 SUB_MS  SP 10 FF  48.5
SV  11   64   1B8C  15     35  0  4403   228   13  144   -4.041 10  0.033   10   1  -2589    99     4        6      2
SV  32   64   104A   6     31  0  444    x      -9   -0     0.000  00  0.000   00   0  -830     99   106     3945     3
SV   4   64   1B8C  15     46  0  4425   132   50  297   1.764  10  0.023   10   1  3034     99     4        6      2
SV   5   0    1000   1      0   0  0      x      -9   -0     0.000  00  0.000   00   0  0        91   106     3945     6
SV   6   64   101A   6     30  0  19     x      -9   -0     0.000 00    0.000   00   0  1181     99   106     3945     6
SV   7   64   198C  15     39  0   4653   45    31  242   0.481  10  0.032   10   1  -999     99     4        6      1
SV  20   64   1B8C  15     48  0  5029   184   56   81    -0.853 10  0.022   10   1  830      99     4        6      1
SV  13   64   1B8C  15     45  0  4317   55    44  202   2.546  10  0.034   10   1  3961     99     4        6      2
SV  25   64   1B8C  15     37  0  3156   x      -9   -0     0.000  00  0.000   00   0  -543     99   106     3945     4
SV   3   54   101A   6     30  0  33     x      -9   -0     0.000  00  0.000   00   0  2174     99   106     3945     5
SV   1   64   1B8C  15     48  0   4141  208   72  120   0.168  10  0.032   10   1  1171     99     4        6      3
SV  16   63   101B   6     30  0  273    x      -9   -0     0.000  00  0.000   00   0  1178     99   106     3945     7
THE_END              42     HC  0  0  0  2
EEPROM read     --------      --------     --------     --------          -------- -----       0x0000     0
EEPROM write    e--e--e-      --e-e---     ---ea---     --------          ---H--- -----       0x0000     0
```


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Software Configuration and version: channels x taps x FFT points, Software version and date

Time tag information: UTC time in hhmmss.sss format, Software time tag (seconds since switch on), Week number, time of week, Fix time (number of seconds with 3D fix), No fix time (number of seconds without 3D fix, Clock bias in metres, Clock drift in metres.

Geod: Latitude, Longitude, Ellipsoidal altitude, Mean sea level altitude

Local: Local grid E,N,U (from initial position), Ground speed, Vertical velocity, Track

Acc: GPS Fix, Fix OK flag, Differential flag, Estimated horizontal accuracy (m), Estimated vertical accuracy (m), Estimated position accuracy (m), Estimated time accuracy (m), Estimated speed accuracy (m/s), Estimated frequency accuracy (m/s), HDOP, VDOP, PDOP

Ext T: External input data e.g. from network assistance

Altitude Position Aiding (APA): APA required flag, APA used flag, Measurement, Variance, Residual, Residual quality

Sigs: Instantaneous pseudorange residuals, Accumulated pseudorange residuals, Pseudorange edit count, Instantaneous doppler residuals, Accumulated doppler residuals, Doppler edit count, Instantaneous delta-range residuals, Accumulated delta-range residuals, Delta-range edit count.

Reset: Kalman reset flag, Last reset type, Number of solutions since last Kalman reset, Total number of resets, Number of solutions since last Kalman Q boost, Week number set flag, Time set flag, Sufficient position flag, Skip check flag, Time to first fix, Time to first fix – ION definition

Satellite Information: Satellite ID, Tracking status (not described), Measurement status, Signal strength (C/No), Mean signal strength, Lock counter, IODE, Elevation angle, Satellite used in solution flag, Pseudorange residuals, Pseudorange residuals OK flag, Pseudorange residuals edit flag, Doppler residuals, Doppler residuals OK flag, Doppler residuals edit flag, Delta-range residuals, Delta-range residuals OK flag, Delta-range residuals edit flag

EEPROM Read & EEPROM Write: Non volatile data usage. The characters shown indicate what data has been read or is written to the EEPROM. a =almanac, e= ephemeris, B=Both (almanac and ephemeris), T=Time, P=Position, H=Height

8.2.2.2 RF & AGC data ($52)

DSP_RF_AGC									
1	1	18	0	AGC & Offset Mode, Current Value					
	0		0	95339	130237	94423	0	0	AGC_counters
	0.0		0.0	29.7	40.6	29.5	0.0	0.0	AGC_counters (%)
0.2	DC	offset	(%)						

AGC: AGC & Offset Mode 1=Auto, 0=Off, Current value of AGC (0-32)

AGC counters: Shows a table of 7 columns, each column indicates the number of times each level has been encountered in the last integration period. The columns indicate levels –3, -2, -1, 0, +1, +2, +3. For the example shown above only three levels are being used so all counts are either –1, 0 or +1.

AGC Counters %: Shows the AGC counters as a percentage. For a 3 level system the optimum AGC setting should have approximately 27%in +1 and –1 and 46% in 0, this represent a Gaussian distribution.

DC Offset: Shows the amount of imbalance in the measured signal. Ideally the DC offset should be zero, but will show a slight DC offset of up to a few percent due to the adjustment resolution in the RF front end.

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8. Communication Protocols continued

8.3 Command Format *

The NavSync Wi125 receiver has a unique set of proprietary commands.

Commands will only be accepted on Port 1.

The commands to and from the unit have the following general formats:

$PRTH<Q|S|R>,<id>,<msg fields>[<checksum>]<cr><lf>*

Where:

< |Q|S|R> is the single ASCII character as follows:

Q: Command, a query command to the Wi125 receiver.

S: Command, requires the Wi125 receiver to set system settings.

R: Response to a Wi125 receiver, response to a $PRTH Query or an acknowledgement of a $PRTH Set.

<id> is a 4 character command identifier.

<msg fields> are the message fields for the message and are all positional. Optional or unknown fields are shown as nulls (ie adjacent commas). Trailing commas to the end of a message (ie nothing but null message fields) are not required.

*<checksum> An optional checksum byte for checking accuracy defined as follows:

The checksum is displayed as a pair of ASCII characters, (0-9 and A-F inclusive) whose value represents the "HEX" value of the checksum byte. When used, it always appears as the last field of the sentence and is prefixed by field delimiter "*" (HEX 2A) instead of "," and followed by <CR><LF> (HEX 0D 0A). The checksum value is calculated by XOR'ing (exclusive OR'ing also known as Modulo 2 Sum) the 8 binary data bits of each valid data character in the sentence between the "$" (HEX 24) and "*" (HEX 2A) characters.

The "$" (HEX 24) and the "*" (HEX 2A) characters are not included in the checksum.

<cr><lf> are the ASCII codes 0Dh and 0Ah (carriage return and line feed) respectively.

Some commands use multiple sentences to transfer data: multiple sentence transfer shall be accomplished by means of 2 fields within the sentence for which this format is used:

t: Total number of sentences forming the data transfer (minimum value 1)

x: ID number of the current sentence ranging from 1 to t inclusive

Null fields within a command shall be interpreted as "use current value" where appropriate. Null fields must be delimited by adjacent commas when they exist between two non-null fields. If all trailing fields after a given field are null, further commas are not required.

***Note**: For Wi125-TIM, the commands include:*
VERS DYNA ITIM RSET INTM ILLH COMA FRQD IDNO ZONE
For Wi125-NAV, the commands include:
VERS DYNA ITIM RSET INTM ILLH COMA FRQD IDNO ZONE
The accuracy testing of INTM command is not yet implemented. Additional commands, some documented here, can be enabled with custom firmware. Further customization is also available. Please consult the factory for details.

8.3.1 PRTH<Q|R>, VERS: Software Version

Purpose

This message Queries and Responds with the current software version information.

Query Format

$PRTHQ,VERS[*checksum]<cr><lf>

Response /Acknowledge Format

$PRTHR,VERS,Build_Name,Version_Number,Version_Date,Version_Time, Serial_Num, BB_Releaset*<checksum><cr><lf>

Explanation of Parameters

Build_Name Product name (i.e. Wi125-TIM or Wi125-NAV)

Version_Number Software version number

Version_Date Software build date in Mmm_dd_yyyy format where Mmm is the Three character abbreviation of the month name\

Version_Time Software build time in hh:mm:ss format

Serial_Num Product serial number is current not implemented and always outputs "Serial_Num"

BB_Release Baseband version number

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8.3.2 PRTH<Q|S|R>, DYNA: RECEIVER DYNAMICS

Purpose

This message Sets, Queries and Responds to the receiver host dynamics and hence the maximum receiver tracking dynamics expected.

The degree of filtering performed by the navigation and timing Kalman filter is dependant on the selected receiver platform.

Query Format

$PRTHQ,DYNA[*checksum]<cr><lf>

Set Format

$PRTHS,DYNA,platform[*checksum]<cr><lf>

Response / Acknowledge Format

$PRTHR,DYNA,platform*<checksum><cr><lf>

Explanation of Parameters

platform receiver platform (integer, range 0 – 10)
- 0 = Fixed base station, Timing and Frequency modes etc
- 1 = Stationary, but unknown position
- 2 = Man pack / walking
- 3 = Automotive / Land Vehicle
- 4 = Marine
- 5 = Airborne, Low dynamics (<1g) — Limit of Wi125
- 6 = Airborne, Medium dynamics <2g)
- 7 = Airborne, High dynamics (<4g)
- 8 = Airborne, Very High dynamics (<8g)
- 9 = Drone, Missile dynamics (<16g)
- 10 = Pure least squares mode (ie semi-infinite dynamics assumed)

Default for Wi125-NAV is 3, maximum is 5. Default for Wi125-TIM is 1 and changes to 0 after 10 minute location survey completed, maximum is 5.

8.3.3 PRTH<Q|S|R>, ITIM: INITIALIZE TIME AND DATE

Purpose

This message Sets, Queries and Responds to the user initialized time and date. Two input options are available, one allowing a calendar date and GMT time to be input and the other a GPS week number and seconds of week.

The input date is acted upon regardless and is primarily used to set the GPS week inside the receiver. The time input will not be used if is set to zero, or if the receiver is currently tracking any satellites and therefore already has a good sub-millisecond knowledge of time.

If the time input is not used then the Response message returns the values used or assumed instead of those input. The time RMS accuracy is used to decide how much importance to put on the input values and should be set with care.

Query Format

$PRTHQ,ITIM[*checksum]<cr><lf>

Set Format

Using a GMT time format

$PRTHS,ITIM,timeRMS,GMT,day,month,year,[hours],[minutes],[seconds] [*checksum]<cr><lf>

Using a GPS time format

$PRTHS,ITIM,timeRMS,GPS,gps_week,[gps_time][*checksum]<cr><lf>

Response / Acknowledge Format

$PRTHR,ITIM,timeRMS,GMT,day,month,year,hours,minutes,seconds,GPS, gps_week,gps_time*<checksum><cr><lf>

Explanation of Parameters

time RMS	RMS accuracy of the input time-tag (seconds) (floating point, range 0 – 999999.0).
day	day of month (integer, range 1 – 31).
month	month of year (integer, range 1 – 12).
year	4 digit year (integer, range 1980 – 2047).
hours	hours of day (integer, range 0 – 23).
minutes	minutes of hour (integer, range 0 – 59).
seconds	seconds of minute (floating point, range 0 – 59.999).
gps_week	GPS week number, including pre GPS roll-over weeks, eg 1037 (integer, range 0 – 32768)
gps_TOW	GPS Time of Week in seconds (floating point, range 0.0 –604800.0).

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8.3.4 PRTH<Q|S|R>, RSET: RE-SET THE RECEIVER

Purpose

This message Sets, Queries and Responds to a receiver re-set command with optional actions such as clearing specific data groups stored in the Wi125 local EEPROM.

The data areas that can be cleared include satellite almanacs, ephemerides, network assist and receiver configuration parameters.

Note that “sleep” mode is not currently supported in the Wi125 technology.

This command invokes a 2 second time-out prior to the reset being called.

Query Format

$PRTHQ,RSET[*checksum]<cr><lf>

Set Format

$PRTHS,RSET,{[option],[option],….}[*checksum]<cr><lf>

Response / Acknowledge Format

$PRTHR,RSET,{[option],[option],….}*<checksum><cr><lf>

A response option of NO, indicates that no reset command is currently activated.

Explanation of Parameters

option

A list of character descriptors to indicate which, if any, of the optional actions are to be undertaken prior to the software re-sets.

”CONFIG” = clear the receiver configuration data stored in EEPROM.
”EPH” = clear the satellite ephemeris data stored in EEPROM.
”ALM” = clear the satellite almanac data stored in EEPROM.
”NA” = clear the network assist data stored in EEPROM.

8.3.5 PRTH<Q|S|R>, INTM: INTERMITTENT OPERATION PARAMETERS

Purpose

This message Queries, Sets and Respond with the Fix Interval, Run Duration, Run Interval, Horizontal and Vertical Accuracy Masks for intermittent operation. Once the receiver has met the required Horizontal and Vertical Accuracy Masks it will go to sleep until the next Run Interval. The receiver will also go to sleep if no fix or the accuracy masks have not been met within the Run Duration.

Query Format

&PRTHQ, INTM [*checksum]<cr><lf>

Set Format

$PRTHS, INTM, Fix_Interval, Run_Duration, Run_Interval, Horizontal_Acc_Mask, Vertical_Acc_Mask[*checksum]<cr><lf>

Response / Acknowledge Format

$PRTHR, INTM*<checksum><cr><lf>

Explanation of Parameters

Fix_Interval	Interval in ms between adjacent fixes
Run_Duration	Maximum time in ms to attempt to obtain fix. Must be greater than Fix_Interval and is 0 for continuous operation
Run_Interval	Time interval in ms between waking to obtain a fix. Must be greater than Run_Duration
Horizontal_Acc_Mask	Required horizontal accuracy in meters before run completes. Zero disables vertical accuracy testing.
Vertiacl_Acc_Mask	Required vertical accuracy in meters before run completes. Zero disables vertical accuracy testing.

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8.3.6 PRTH<Q|S|R>, ILLH: INITIALIZED LAT, LONG, HEIGHT POSITION

Purpose

This message Sets, Queries and Responds to the initialized geodetic position (latitude, longitude, ellipsoidal height and antenna height above the reference marker) in the receiver's current user datum.

The position RMS accuracy is used to decide how much importance to put on the input values and should be set with care.

Query Format

$PRTHQ,ILLH[*checksum]<cr><lf>

Set Format

$PRTHS,ILLH,LatDeg,LatMin,LatSec,LatH,LonDeg,LonMin,LonSec,LonH,EllHt,AntHt,posRMS [*checksum]<cr><lf>

Response / Acknowledge Format

$PRTHR,ILLH,LatDeg,LatMin,LatSec,LatH,LonDeg,LonMin,LonSec,LonH,EllHt,AntHt,posRMS*<checksum><cr><lf>

Explanation of Parameters

LatDeg	Latitude degrees (floating point, range ±90.0)
LatMin	Latitude minutes (floating point, range ±59.999999)
LatSec	Latitude seconds (floating point, range ±59.99999)
LatH	Latitude hemisphere (char 'N' or 'S')
LonDeg	Longitude degrees (floating point, range ±90.0)
LonMin	Longitude minutes (floating point, range ±59.999999)
LonSec	Longitude seconds (floating point, range ±59.99999)
LonH	Longitude hemisphere (char 'E' or 'W')
EllHt	Height of the reference marker above the current user datum reference ellipsoid in metres (floating point, range ±18,000.0)
AntHt	Height of the antenna phase centre above the reference marker height defined by EllHt above in metres (floating point, range ±18,000.0)
posRMS	RMS accuracy of the input position (metres) (floating point, range 0 - 999999.0)

Note that since the Degree, Minutes and Seconds fields will accept floating point values then a decimal degree value, or and integer degree, decimal minute value can be input directly by setting the minutes and seconds fields to zero as appropriate (eg 52.12345678,0,0,N or 52,14.123456,0,N).

8.3.7 PRTH<Q|S|R>, COMA: COMA MODE

Purpose

This message Sets, Queries and Responds Coma mode. Coma mode puts the receiver to sleep for a predetermined period of time.

Query Format

$PRTHQ,COMA[*checksum]<cr><lf>

Set Format

$PRTHS,COMA,Period[*checksum]<cr><lf>

Response / Acknowledge Format

$PRTHR,COMA,Period*<checksum><cr><lf>

Explanation of Parameters

Period The period in milliseconds that the receiver will sleep.

8.3.8 PRTH<Q|S|R>, FRQD: FREQUENCY OUTPUT SELECT

Purpose

This message Sets, Queries and Responds the Frequency Output. Outputs the requested frequency from the GPIO [0] port as detailed in section 13.

Query Format

$PRTHQ,FRQD[*checksum]<cr><lf>

Set Format

$PRTHS,FRQD,Frequency[*checksum]<cr><lf>

Response / Acknowledge Format

$PRTHR,FRQD,Frequency*<checksum><cr><lf>

Explanation of Parameters

Frequency The frequency in Megahertz that the receiver will output. Wi125-TIM defaults to 10 MHz, 30 MHz maximum. Wi125-NAV defaults to 0 MHz (disabled), 20 MHz maximum. e.g. for 10kHz = 0.010

0 = switch digital frequency off.

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8.3.9 PRTH<Q|S|R>, MMSV: MIN & MAX SATELLITES FOR A POSITION SOLUTION

Purpose

This message Sets, Queries and Responds to the minimum and maximum number of satellites the receiver will use for a position solution. Increasing the minimum number of satellites will improve the accuracy achieved when sufficient satellites are available, but may reduce the time when a solution can be produced. Reducing the maximum number of satellites may reduce the accuracy of the position solution, but will decrease the amount of processing power required for the solution.

Note that setting the Maximum satellites to less than 4 will prevent the receiver from performing a 3D position solution. Likewise setting the minimum number of satellites greater than 3 will prevent the receiver performing a 2-D, altitude fixed solution.

The maximum must be greater than or equal to the minimum number of satellites.

Query Format

$PRTHQ,MMSV[*checksum]<cr><lf>

Set Format

$PRTHS,MMSV,[min_NSV],[max_NSV][*checksum]<cr><lf>

Response / Acknowledge Format

$PRTHR,MMSV,min_NSV,max_NSV*<checksum><cr><lf>

Explanation of Parameters

min_NSV Minimum Satellites used for a position / time solution (integer, range 0-12)

max_NSV Maximum Satellites used for a position / time solution (integer, range 0-12)

8.3.10 PRTH<Q|S|R>, DRLM: DEAD RECKONING LIMIT

Purpose

This message Sets, Queries and Responds to the limit for the forward predictive Dead Reckoning, after the last valid fix (epochs). The dead reckoning will progress at constant velocity for the first half of this period and then reduce to a standstill during the second half.

Note that since this value has units of epochs, it will have a different effect on a 1Hz Wi125 receiver to that on a 2Hz, 5Hz or 10Hz Wi125 receivers.

Query Format

$PRTHQ,DRLM[*checksum]<cr><lf>

Set Format

$PRTHS, DRLM,DR_Limit[*checksum]<cr><lf>

Response / Acknowledge Format

$PRTHR, DRLM, DR_Limit*<checksum><cr><lf>

Explanation of Parameters

DR_Limit Number of epochs to dead reckon for (integer, range 0 –32768)

8.3.11 PRTH<Q|S|R>, ELVM: SATELLITE ELEVATION MASK

Purpose

This message Sets, Queries and Responds to the satellite elevation mask angle below which satellite data will not be used in the navigation and time solution.

Query Format

$PRTHQ,ELVM[*checksum]<cr><lf>

Set Format

$PRTHS,ELVM,nvElevMask[*checksum]<cr><lf>

Response / Acknowledge Format

$PRTHR,ELVM,nvElevMask*<checksum><cr><lf>

Explanation of Parameters

nvElevMask the navigation and time solution elevation mask angle in degrees (integer, range 0 –90).

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8.4 Network Assistance Input

The Wi125 uses network assistance data to allow acquisition and tracking of GPS satellites in low signal levels. The network assistance data is base on the TIA/EIA/IS-801 specification as using the CDMA network. The format used is an ASCII version of the data to allow the contents of the messages to be displayed on a terminal. The data format is that used by the NavSync Network Assistance Base Station Simulator.

This section defines the transport mechanism for transferring the CDMA GPS messages in serial form from the Base Station Simulator in TIA/EIA/IS-801 format. As only a subset of the whole message set defined in TIA/EIA/IS-801 is required, this section defines the format for each of the required messages and provides references to the relevant section of TIA/EIA/IS-801.

Three messages are required:

Base Station response, Provide Location Response message (TIA/EIA/IS-801 section 4.2.4.2 page 4-51)

Base Station response, Provide GPS Almanac message (TIA/EIA/IS-801 section 4.2.4.2 page 4-41)

Base Station response, Provide GPS Ephemeris message (TIA/EIA/IS-801 section 4.2.4.2 page 4-44)

The messages should be sent out in the order Provide Location Response, Provide GPS Almanac, and Provide GPS Ephemeris. The messages are variable length and flags within the messages identify the inclusion or exclusion of various sub-fields. If all of the data for a message is not valid then the message should be omitted. If any of the data for a message is valid then the message should be sent.

The message syntax is specified in BNF (Backus-Naur-Form).

8.4.1 Message Definition

MessageSet ::= <MessageLine>*

MessageLine ::= <Header><MsgHexOctets><Footer>

Header ::= <GSMHeader> | <CDMAHeader>

CDMAHeader ::= #CDMA,<CDMAType>,<CDMAMessageType>

CDMAType ::= 0 Note: 0 specifies TIA/EIA/IS-801 format.
Other values reserved for future use

CDMAMessageType :: = 0 | 1 | 2 Note: 0 = Provide Location Response
1 = Provide GPS Almanac
2 = Provide GPS Ephemeris

MsgHexOctets ::= <HexOctet>... message data ...<HexOctet>

The data content of the MsgHexOctets data is defined in section 2 of this document.

Footer ::= &<Checksum><CR><LF>

Checksum ::= HexOctet Note: Lower 8 bits of the addition of all characters between the starting # and the & before the checksum (non-inclusive).

CR ::= ASCII carriage return character

LF ::= ASCII line feed character

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9. NMEA and UART CONFIGURATION DETAILS

This section describes how the NMEA and UART output can be configured for different Refresh Rates, Contents and Baud Rates.

- NMEA Output Configuration (i.e. output frequency) Query:
  $PRTHQ, U1OP
  $PRTHQ, U2OP
  $PRTHQ, U3OP

- NMEA Output Configuration (i.e. output frequency) Set:
  $PRTHS, U1OP
  $PRTHS, U2OP
  $PRTHS, U3OP

- UART Configuration (i.e. baud rate) Query:
  $PRTHQ, U1CM
  $PRTHQ, U2CM
  $PRTHQ, U3CM

- UART Configuration (i.e. baud rate) Set:
  $PRTHS, U1CM
  $PRTHS, U2CM
  $PRTHS, U3CM

9.1 NMEA Configuration Query ($PRTHQ, UxOP):

The command takes the form “$PRTHQ,UxOP” where x is a port number. On the Wi125 platform, the port number is always between 1 and 3 inclusive.

The remainder of the strings is of the form “$PRTHR,UxOP,GLL=1,GSV=4,PLT=1” where x is the port number for which the information was requested. The specific contents supported are dependent on the NMEA sentences supported by the system. Only the settings which are to be altered need to be listed. A NMEA checksum of the form “*4D” is appended to the output string.

The list of currently supported NMEA sentences is as shown below. To turn a sentence output off completely, simply specify zero as the duration for that command. Subsequent commands may reassign an output period to sentences disabled in this way, effectively re-enabling the output sentence. This command also supports a shortcut by means of an “ALL” specifier. When this is encountered, the period specified is applied to all sentences. An example of this is shown below, where every message output on port1 will be printed at a 5-second period with the exception of the GPRMC sentence, which will be output every second, and the POLYT sentence, which will be disabled.

$PRTHS, U1OP, ALL=5, RMC=1. PLT=0

An example response string is shown below. In this example, all sentences are output every second, except GPGSV, which is output every three seconds, and POLYT, which is not output at all (i.e. the sentence output is disabled).

$PRTHR,U1OP,GLL=1,RMC=1,VTG=1,GGA=1,GSA=1,GSV=3,PLT=0,PLP=1,PLS=1,PLI=1*0C

9.2 NMEA Configuration Set ($PRTHS,UxOP):

The command takes the form “$PRTHS,UxOP,GLL=2,GGA=4,GSV=0” where x is a port number. On the Wi125 platform, the port number is always between 1 and 3 inclusive.

The remainder of the string is of the form “GLL=1,GSV=4,PLT=1”. The specific contents supported are dependent on the NMEA sentences supported by the system. Only the settings which are to be altered need to be listed. A NMEA checksum of the form “*4D” is appended to the output string.

The list of currently supported NMEA sentences are as shown above for the Query command. To turn a sentence output off completely, simply specify zero as the duration for that command. Subsequent commands may reassign an output period to sentences disabled in this way, effectively re-enabling the output sentence. This command also supports a shortcut by means of an “ALL” specifier. When this is encountered, the period specified is applied to all sentences. An example of this is shown below, where every message output on port 1 will be printed at a 5-second period with the exception of the GPRMC sentence, which will be output every second, and the POLYT sentence, which will be disabled.

$PRTHS,U1OP,ALL=5,RMC=1,PLT=0

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9.3 UART Configuration Query ($PRTHQ, UxCM):

The command takes the form “$PRTHQ,UxCM” where x is a port number. On the Wi125 platform, the port number is always between 1 and 3 inclusive.

The response string is of the form “$PRTHR,UxCM,38400,38400,N,1” where x is the port number for which the information was requested. The remainder of the string, “38400,38400,N,1” represents the port Tx baud rate, Rx baud rate, parity and stop bits respectively. A NMEA checksum of the form “*4D” is appended to the output string.

Although the format of the command supports the use of different Rx and Tx baud rates, this is not currently supported by the Wi125 platform. Consequently, the Rx and Tx baud rates returned will always be identical.

9.4 UART Configuration Set ($PRTHQ,UxCM)

The command takes the form “$PRTHS,UxCM,57600,57600,N,1” where x is a port number. On the Wi125 platform, the port number is always between 1 and 3 inclusive.

The remainder of the string, “57600,57600,8,N,1” represents the port Tx baud rate, Rx baud rate, parity and stop bits respectively.

Although the format of the command supports the use of different Rx and Tx baud rates, this is not currently supported by the Wi125 platform. Consequently, the Rx and Tx baud rates must always be specified to be the same value. In addition, the Wi125 platform does not currently support the use of parity, or of stop bit settings other than 1 stop bit. The supported baud rates are: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, and 230400.

If a command is issued which is badly formatted or does not adhere to these constraints, it will be discarded. This command is intended for use with the NMEA port(s) only. Caution should be exercised when using this command to change the baud rate on other ports, since data may be lost during the configuration change.

It should be noted that these commands allow the system to be configured at 1200 baud, while requesting that the full set of NMEA sentences be output each second. Such configurations will result in NMEA corruption since the output NMEA data rate exceeds the underlying baud rate.

10. LED INTERFACE

There are two output ports designed to drive external LED’s, namely LED_RED and LED_GRN (pins 8 & 9 respectively).

Normally this signal is used to drive a green and red LED external to the module. Standard software builds use these signal to indicate GPS status. This signal has a 3.3V CMOS drive. A series limiting resistor is required to limit output current to ±5mA (typically 470 ohms). The signal return path is DIG_GND.

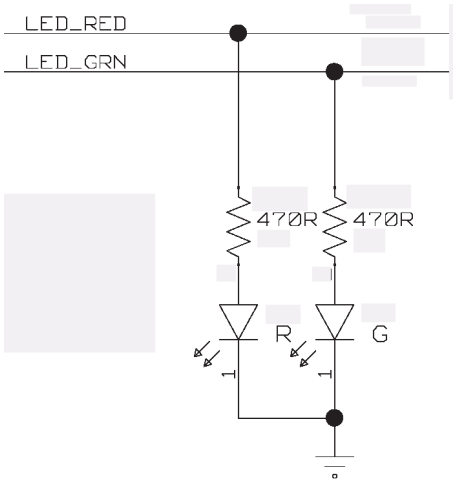

Figure 5 LED Interface

The LEDs are used to indicate the operating state of the GPS receiver. An initial long flash indicates the GPS fix mode.

RED - No Fix, 1pps Invalid

RED and GREEN - Dead Reckoning, 1pps valid

GREEN - GPS Fix, 1pps valid

Each long flash may be followed by up to 12 shorter GREEN or RED flashes. Each GREEN or RED short flash indicates a satellite being tracked. A GREEN LED indicates a satellite being tracked and used in the time or position solution and an RED LED a satellite being tracked but not used in the solution.

When the GPS receiver is held in reset state (the reset button pushed in) all the LEDs are switched ON.

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11. ILD NETWORK ASSIST MESSAGE FORMAT

This section defines the ILD (Indoor Location Demonstrator) format Network Assistance Base Station messages output from a Navsync Base Station.

These messages are suitable for use as a Network Assistance input to the Wi125 receiver module. They are a series of ASCII comma separated messages which are output from UART3 of the Wi125 based ILD Base Station Receiver at 38400,8,N, 1.

Each message starts with a # character and ends with a <CR><LF>.

Prior to the end of the message there is a '&' character followed by an 8-bit accumulative checksum of all bytes in-between the # and & characters in represented in ASCII hexadecimal.

For simplicity, the messages that contain data normally transmitted in the GPS satellite's Navigation Messages, contain the data formatted and scaled as closely as possible to it. These are also very close to the data structures that are used at the NS3K and XG4K API interfaces and hence minimizes the data manipulation in the user application code outside the GPS_Core API interface.

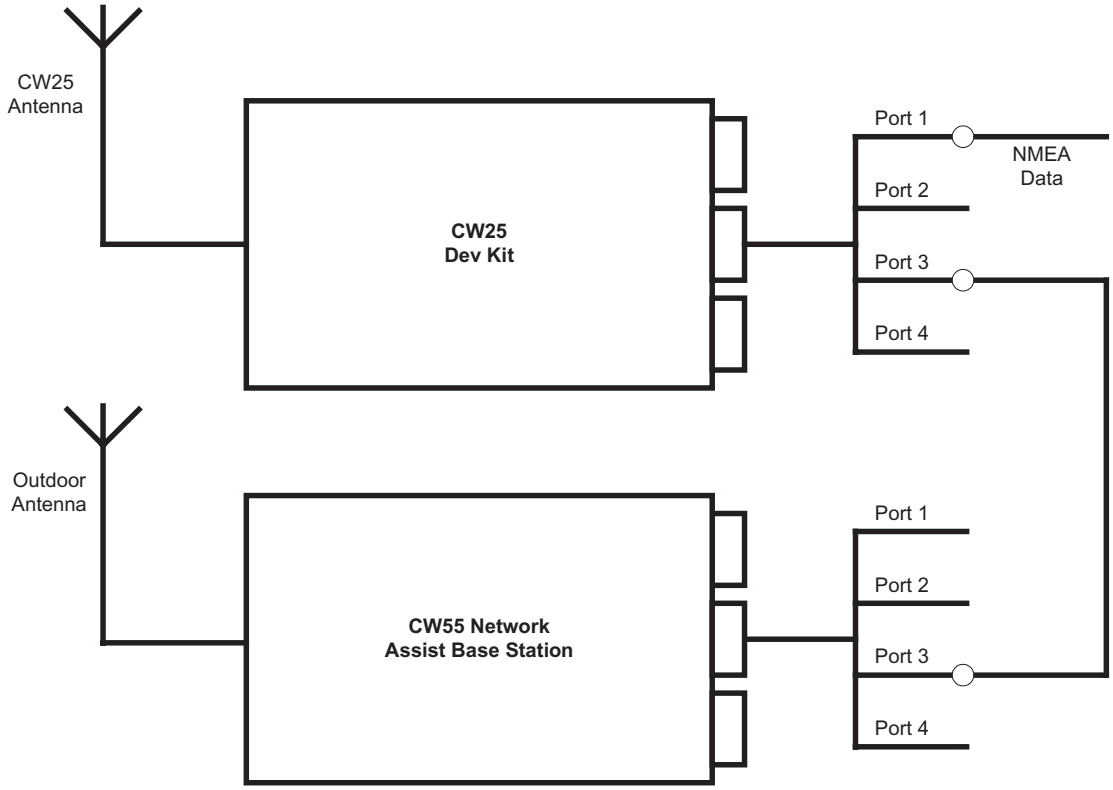

Figure 6 Network Assist Structure

WTP, Week, Time, Position Message

This message is output every second provided the ILD Base Station has obtained a valid accurate 3D GPS fix in the last 60 minutes. This long 60 minutes time-out enables a Base Station to be initialized outdoors, and then taken indoors to initialize an ILD Mobile receiver (e.g. via a wire link) without having to maintain lock on satellites itself.

This message does not contain any position uncertainty estimates, corresponding to the known cell size, as these are added at the mobile end for demonstrator systems. This message will be superseded by new #TIM and #LOC messages for any end user products that use these messages.

#WTP, week, TOW, ECEF-X, ECEF-Y, ECEF-Z, FrqCal&cs

#WTP, 1282,467123.907,3912409, -78922,5020018, &DA

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Name	Description
#WTP	Base Station Week, Time, and Position data.
week	GPS Week Number (blank if unknown)
TOW	GPS Time of Week (seconds) of transmission of the # character at the start of the message (approx +/-20 msec accuracy)
ECEF-X	Base Station ECEF Position, X coordinate (metres)
ECEF-Y	Base Station ECEF Position, X coordinate (metres)
ECEF-Z	Base Station ECEF Position, X coordinate (metres)
FrqCal	Optional GPS reference clock frequency calibration word. The units are system dependant. Under normal usage this field should be left blank.
cs	8-bit accumulative checksum of all bytes in-between the # and & characters in hexadecimal.

11.1 Message Definitions

11.1.1 #EPH, Ephemeris Sub frame Message

This message is output approximately once a second, and hence takes up to16 seconds to transmit an Ephemeris for all satellites in view. .

#EPH, SV, W [1], ... , W [24]&cs

#EPH, 27,409000,191EA0,D180AF, B1A11B, D70FF6, A17241, 0000A0, 2E0662,
A1FBD8, 349A61,E6DEFE, FBE609, 5CBA11, 0ADAA1, 0DAEAD, 724135,00216F,
302D23,FF4726, B8F287, 221CA8,A1D0AE, FFA787, A1018D&DE

Name	Description
#EPH	GPS Navigation Message Ephemeris data for a single satellite. *See ICD-GPS-200 for full details.*
SV	SV id number for the ephemeris data to follow
W [i]i=1 to 24	24 words of the Ephemeris subframes data from words 3 to 10 of subframes 1, 2 and 3 of the GPS Navigation Message. *Each of the raw 30 bit data words have been logically shifted 6 bits to the right to remove the 6 parity bits leaving the 24 data bits seen in the above example.*
cs	8-bit accumulative checksum of all bytes in-between the # and & characters in hexadecimal.

11.1.2 #ALM, Almanac Subframe Message

This message is output approximately twice every seconds, and hence takes up to16 seconds to transmit a complete set of Almanacs.

#ALM, SV, week, W [1], ... , W [8]&cs

#ALM, 20,1283,54133D, 0F0DC9,FD4100, A10C6F, 16E0FE, 41DD95,D2B291,
EE002D&92

Name	Description
#ALM	GPS Navigation Message Almanac data for a single satellite. *See ICD-GPS-200 for full details.*
SV	SV id number for the almanac data to follow
week	Almanac reference GPS week number
W [i]i=1 to 8	8 words of almanac data from words 3 to 10 of the Almanac pages of subframes 4 or 5 of the GPS Navigation Message. *Each of the raw 30 bit data words have been logically shifted 6 bits to the right to remove the 6 parity bits leaving the 24 data bits seen in the above example.*
cs	8-bit accumulative checksum of all bytes in-between the # and & characters in hexadecimal.

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11.1.3 #KLB, Klobuchar Ionospheric Parameters Message

This message is output approximately once every 16 seconds.

#KLB, a0, a1, a2, a3, b0, b1, b2, b3&cs

#KLB, 5,2, -1, -2,38,3, -1, -4&BA

Name	Description		
#KLB	GPS Navigation Message Klobuchar ionospheric delay correction model parameters. See ICD-GPS-200 for full details.		
a0	a_0	(x 2^{-30}	seconds)
a1	a_1	(x 2^{-27}	seconds per semicircle)
a2	a_2	(x 2^{-24}	seconds per semicircle^2)
a3	a_3	(x 2^{-24}	seconds per semicircle^3)
b0	b_0	(x 2^{11}	seconds)
b1	b_1	(x 2^{14}	seconds per semicircle)
b2	b_2	(x 2^{16}	seconds per semicircle^2)
b3	b_3	(x 2^{16}	seconds per semicircle^3)
cs	8-bit accumulative checksum of all bytes in-between the # and & characters in hexadecimal.		

11.1.4 #UCP, UTC Correction Parameters Message

This message is output approximately once every 16 seconds.

#UCP, A1, A0, Tot, WNt, dtLS, WNLSF, DN, dtLSF&cs

#UCP, -20, -8,15,3,13,222,5,13&68

Name	Description		
#UCP	GPS Navigation Message UTC Correction model Parameters. See ICD-GPS-200 for full details.		
A1	A_0	(x 2^{-30}	seconds)
A0	A_1	(x 2^{-50}	seconds/second)
Tot	Tot	(x 2^{12}	seconds)
WNt	WN_t	(x 1	weeks)
DtLS	Dt_{LS}	(x 1	seconds)
WNLSF	WN_{LSF}	(x 1	weeks)
DN	DN	(x 1	days)
DtLSF	Dt_{LSF}	(x 1	seconds)
cs	8-bit accumulative checksum of all bytes in-between the # and & characters in hexadecimal.		

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11.1.5 #TIM, Time Input Message

This message is output every seconds to provide an approximate starting GPS Time.

This message has not currently been implemented.

#TIM, week, TOW, TOW_rms, FS_TOW, FS_rms&cs

Without a Frame Synch pulse input

#TIM, 1282,467123.907,10, &hh

With a 1PPS with 100 nsec RMS accuracy used as a Frame Synch pulse input

#TIM, 1282,467123.907,10,467123.000000000,100, &hh

Name	Description
#TIM	Time input data.
week	GPS Week Number (blank if unknown)
TOW	GPS Time of Week (seconds) of transmission of the # character at the start of the message
TOW_rms	RMS accuracy (integer milliseconds) of the above TOW relative to when the # character was transmitted.
FS_TOW	GPS Time of Week (seconds) of the last Frame Synch pulse inserted. Leave blank if it is unknown, or no pulse was sent.
FS_rms	RMS accuracy
FrqCal	Optional GPS reference clock frequency calibration word. The units are system dependant. Under normal usage this field should be left blank.
cs	8-bit accumulative checksum of all bytes in-between the # and & characters in hexadecimal.

11.1.6 #LOC, Location Message

This message is output every seconds and provides an estimate of the user's location along with an uncertainty for this estimate.

This message has not currently been implemented.

In many Network Assistance applications the location provided will be the position of the Base Station itself, and the uncertainty will be sufficiently large to cover all possible positions that a user able to communicate with that Base Station could be located at. In this case the RMS uncertainty should be set to the maximum cell size / 3, for a 3-sigma limit.

#LOC, Lat, Long, Alt, Unc_SMaj, Unc_SMin, Unc_Brg, Unc_Vert&cs

For an input location of 52 14.971 N, 1 09.354W, and 203m altitude, with a circular horizontal uncertainty of 3 km RMS and a vertical uncertainty of 200m RMS.

#LOC, 5214971, -109354,203,3000,3000,0,200&hh

Name	Description
#LOC	Location input data
Lat	WGS84 geodetic latitude formatted as: (Latitude_degrees * 100000 + Latitude_minutes * 1000) +ive North.
Lon	WGS84 geodetic longitude formatted as: (Longitude_degrees * 100000 + Longitude_minutes * 1000) +ive East.
Alt	WGS84 ellipsoidal altitude (metres)+ive Up.
Unc_SMaj	Horizontal RMS uncertainty semi-major axis (metres)
Unc_SMin	Horizontal RMS uncertainty semi-minor axis (metres)
Unc_Brg	Horizontal RMS uncertainty bearing of semi-major axis (degrees)
Unc_Vert	Vertical RMS uncertainty bearing of semi-major axis (metres)
cs	8-bit accumulative checksum of all bytes in-between the # and & characters in hexadecimal.

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11.1.7 Example Sequence Of Messages

This is an example of a sequence of message for a Demonstrator system (i.e. #WTP messages are used rather than the new and still to be implemented #TIM and #LOC messages). The blank line does not exist in reality, and has only been inserted to show where a gap exists in the transmission bursts.

#WTP, 1282,467130.051,3912410, -78920,5020020, &BD

#EPH, 01,409101,111EA0,D180AF, B1A11B, D70FF9, 977242,00000F, 2ECB20, 9701FE, 2B44A2, 48C011, 018D02,B391A6, 110EA1, 051E1D, 72427D, 002747,E62DBD, FFE127, EDA07F, 1D67BC, 612361,FFAB6F, 97057C&66

#ALM, 31,1283,5F6302, 0FFBE7,FD4500, A10D3C, BFB770, 283629,171561,25006B&4D

#ALM, 01,1283,412B43, 0F1879,FD5F00, A104C7, 42EDF7,BC5419, 3D242B, 2E001E&67

#WTP, 1282,467131.075,3912410, -78919,5020021, &CD

#EPH, 04,409000,191EA0,D180AF, B1A11B, D70FF3, DA7242, 00FF7E,E0784B, DA00CE, 36AD6B, 133310,00EC03, 65D59D, 098BA1, 0D9E63, 72424C,FF97F2, 66D059, 002327,10BCB9, 2490FD,AD84C2, FFA4B2, DAFBFE&04

#ALM, 03,1283,432F7E, 0FF64D,FD3B00, A10D11, BEB470, 15D9EF, 7CA673, 040031&84

#ALM, 04,1283,443663,0F0AA4,FD4500, A10D41, ED6DD4, FDA9F2, 052B62,E0FF85&9E

#WTP, 1282,467132.099,3912410, -78919,5020022, &D5

#EPH, 05,409103,1DDDE3,D180AF, B1A11B, D70FF7, 387080,00000F, 059C84, 38FB53, 375532,23061B,FBAC02, CBD5FA, 13B4A1, 0DCF97, 70807C,FFDC99, 1E10E7, 000626,261485,16E322,EB337C, FFA480, 38F9C1&93

#ALM, 05,1283,452CD1, 0FFBF7,FD3C00, A10D46, 94244E, 22EAF7,F70045, 050016&68

#ALM, 06,1283,463678,0FFB30,FD4300, A10D92, C0E3E9, AF2AD0, 280C02, 2D014F&72

#WTP, 1282,467133.123,3912410, -78918,5020022, &C9

#EPH, 06,409001,191EA0,D180AF, B1A11B, D70FF5, 4B7242, 000145,2C7A40, 4B084E, 38258E, 0A93F7, 068403,6813BB, 1294A1, 0E1379, 72427F, 0059C5,DCF2CA, FFE026, 199E24, 1831AF, 1F3454,FFA567, 4B0CA5&41

#ALM, 07,1283,476B8C, 0FFC42,FD4500, A10C34, BFC27E, B5493D, 7DE84A, 36FF7D&DA

#ALM, 08,1283,484AA1, 0F0F3E,FD5700, A10C85, 6DEFF7, 630BEA, 2ECA8F,FF0004&D3

#WTP, 1282,467134.147,3912410, -78918,5020023, &D1

#EPH, 07,409000,191EA0,D180AF, B1A11B, D70FFC, 827241,00FF54, 376860,8209B4, 38FCE3,AAEB14, 08BC06,B924E7, 129CA1, 0CAD61, 72412A,FFC2C4, BB803E, 006626,2AC533, 1954B5, 42FB87,FFA246, 820D5F&9D

#ALM, 09,1283,49831A, 0F06BA,FD4D00, A10D21, 6B1798, 2BACC4, 1CCC36,F8FFED&D3

#ALM, 10,1283,4A3140, 0F186D,FD5000, A10DC1, 17BA55, 0CF794,AB51B6, 06000F&4F

#WTP, 1282,467135.171,3912410, -78917,5020024, &CF

#EPH, 10,409201,091EA0,D180AF, B1A11B, D70FFB, E97242, 000006,06598F,E9FAD2, 2D0F11, 45B59C,FBAD03, 147CC7, 11F7A1, 0E1E37, 72427C, 00231C,B2DB46, 001A27,ED6AE7, 1B720C,FA5223, FFA8BA, E9F011&B5

#ALM, 11,1282,4B18FE, 90E825,FD1400, A10CF2, ED07E2, 02BFAA, 7EA606, 12002A&86

#ALM, 13,1283,4D1370, 0F1B34,FD6400, A10CA5, 423D1E, 25448B,AD34F8, FC001B&68

#WTP, 1282,467136.195,3912411, -78917,5020024, &D7

#EPH, 11,409101,1DDDE3,D180AF, B1A11B, D70FE7, 207080,00001B, 12253A, 200267,43937F,DD1C4E, 022C01, 8F160C, 07CEA1, 0D7145, 70807E,FFE2ED, 13C163,FFE024, E8BFB7, 22D002,C42A93, FF9E52, 20FC47&7A#ALM, 14,1283,4E0AB1, 0F1791,FD5D00, A10CB3, 41D87B,BB15FC, 79C4E8,FC0019&AB

#ALM, 15,1283,4F4826, 0F0F3F,FD4C00, A10CDC, EF95B3, 5D7FC0, 24AD4C, 27003F&C1

#WTP, 1282,467137.219,3912411, -78916,5020025, &D5

#KLB, 5,2, -1, -2,38,3, -1, -4&BA

#UCP, -20, -8,15,3,13,222,5,13&68

#ALM, 16,1283,5014B5, 0F0C4C,FD5500, A10C39, 97277F,C8792E, FAD2CF, 010002&6E

#ALM, 17,1282,518D10, 90108E,FD4900, A10CD1, F63811, 8FCC07, 7F941E,F0FFB0&8A

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#WTP, 1282,467145.411,3912415, -78915,5020028, &D4

#EPH, 25,409201,091EA0,D180AF, B1A11B, D70FF0, 9D7242, 000007,098A6F, 9DFD25, 35BEA2, 3A5296,FDB305, CA1705, 0ADBA1, 0E03CB, 72427D, 00656E, 04A569, 001426,89A0F5, 21F3C0, 67A21D,FFA678, 9D02CC&77

#ALM, 01,1283,412B43, 0F1879,FD5F00, A104C7, 42EDF7,BC5419, 3D242B, 2E001E&67

#ALM, 03,1283,432F7E, 0FF64D,FD3B00, A10D11, BEB470, 15D9EF, 7CA673, 040031&84

#WTP, 1282,467146.435,3912415, -78915,5020028, &DB

#EPH,27,409000,191EA0,D180AF,B1A11B,D70FF6,A17241,0000A0,2E0662,A1FBD8,349A61,E6DEFE,FBE609,5CBA11, 0ADAA1,0DAEAD,724135,00216F,302D23,FF4726,B8F287,221CA8,A1D0AE,FFA787,A1018D&DE

#ALM,04,1283,443663,0F0AA4,FD4500,A10D41,ED6DD4,FDA9F2,052B62,E0FF85&9E

#ALM,05,1283,452CD1,0FFBF7,FD3C00,A10D46,94244E,22EAF7,F70045,050016&68

#WTP,1282,467147.459,3912415,-78915,5020028,&E2

#EPH,30,409000,191EA0,D180AF,B1A11B,D70FEE,4E7241,00FFF8,48D37F,4EFB8E,34F335,F1519A,FC1C03,DC94E1, 141EA1,0D0033,724138,FFBC9A,D199EE,FFD026,6D77D3,170033,909B7A,FFA52A,4EFA5E&35

#ALM,06,1283,463678,0FFB30,FD4300,A10D92,C0E3E9,AF2AD0,280C02,2D014F&72

#ALM,07,1283,476B8C,0FFC42,FD4500,A10C34,BFC27E,B5493D,7DE84A,36FF7D&DA

#WTP,1282,467148.483,3912416,-78915,5020029,&E2

#EPH,31,409000,191EA0,D180AF,B1A11B,D70FF3,CA7242,00006A,24E7EF,CA0977,373D7D,0A92EB,07AF06,2F3ECA, 125CA1,0DB9AB,72426A,0018C4,B06F84,FFAB26,251630,18BF28,2C5A53,FFA758,CA0B3B&DB

#ALM,08,1283,484AA1,0F0F3E,FD5700,A10C85,6DEFF7,630BEA,2ECA8F,FF0004&D3

#ALM,09,1283,49831A,0F06BA,FD4D00,A10D21,6B1798,2BACC4,1CCC36,F8FFED&D3

#WTP,1282,467149.507,3912417,-78915,5020029,&E1

#EPH,01,409101,111EA0,D180AF,B1A11B,D70FF9,977242,00000F,2ECB20,9701FE,2B44A2,48C011,018D02,B391A6, 110EA1,051E1D,72427D,002747,E62DBD,FFE127,EDA07F,1D67BC,612361,FFAB6F,97057C&66

#ALM,10,1283,4A3140,0F186D,FD5000,A10DC1,17BA55,0CF794,AB51B6,06000F&4F

#ALM,11,1282,4B18FE,90E825,FD1400,A10CF2,ED07E2,02BFAA,7EA606,12002A&86

#WTP,1282,467150.531,3912417,-78914,5020030,&CD

#EPH,04,409000,191EA0,D180AF,B1A11B,D70FF3,DA7242,00FF7E,E0784B,DA00CE,36AD6B,133310,00EC03,65D59D, 098BA1,0D9E63,72424C,FF97F2,66D059,002327,10BCB9,2490FD,AD84C2,FFA4B2,DAFBFE&04

#ALM,13,1283,4D1370,0F1B34,FD6400,A10CA5,423D1E,25448B,AD34F8,FC001B&68

#ALM,14,1283,4E0AB1,0F1791,FD5D00,A10CB3,41D87B,BB15FC,79C4E8,FC0019&AB

#WTP,1282,467151.555,3912418,-78914,5020030,&D5

#EPH,05,409103,1DDDE3,D180AF,B1A11B,D70FF7,387080,00000F,059C84,38FB53,375532,23061B,FBAC02,CBD5FA, 13B4A1,0DCF97,70807C,FFDC99,1E10E7,000626,261485,16E322,EB337C,FFA480,38F9C1&93

#ALM,15,1283,4F4826,0F0F3F,FD4C00,A10CDC,EF95B3,5D7FC0,24AD4C,27003F&C1

#ALM,16,1283,5014B5,0F0C4C,FD5500,A10C39,97277F,C8792E,FAD2CF,010002&6E

#WTP,1282,467152.579,3912418,-78914,5020031,&DD

#KLB,5,2,-1,-2,38,3,-1,-4&BA

#UCP,-20,-8,15,3,13,222,5,13&68

#ALM,17,1282,518D10,90108E,FD4900,A10CD1,F63811,8FCC07,7F941E,F0FFB0&8A

#ALM,18,1282,522AA4,900DCE,FD4700,A10D0E,1DF18C,88F19F,28FEAD,F7FFF8&FA

#WTP,1282,467153.603,3912419,-78914,5020031,&D3

#EPH,06,409001,191EA0,D180AF,B1A11B,D70FF5,4B7242,000145,2C7A40,4B084E,38258E,0A93F7,068403,6813BB, 1294A1,0E1379,72427F,0059C5,DCF2CA,FFE026,199E24,1831AF,1F3454,FFA567,4B0CA5&41

#ALM,19,1283,531D34,0F0B61,FD5700,A10C3B,C40980,B01E11,C94607,FE0028&41

#ALM,20,1283,54133D,0F0DC9,FD4100,A10C6F,16E0FE,41DD95,D2B291,EE002D&92

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#WTP, 1282,467138.243,3912412, -78916,5020026, &D5

#EPH, 13,409000,191EA0,D180AF, B1A11B, D70FE8, B17242, 000006,FCC7B1, B10249, 2AFD13, 2B281F, 01F801, 37728C, 1117A1, 0CFC41, 72427F,FFC547, 35343B, 003528,195810,1D4B25, 2CC22A,FFAA94, B10849&11

#ALM, 18,1282,522AA4, 900DCE,FD4700, A10D0E, 1DF18C, 88F19F, 28FEAD,F7FFF8&FA

#ALM, 19,1283,531D34, 0F0B61,FD5700, A10C3B, C40980, B01E11, C94607, FE0028&41

#WTP, 1282,467139.267,3912412, -78916,5020026, &DC

#EPH, 14,409001,15DDE3,D180AF, B1A11B, D70FEA, 987080,00FFFA,FCC5C4, 980134,2BC2B4, 9B6179, 00CD00,AA3442, 10B8A1, 0D0B72, 70807E, 002E46,D14B00, FFFD27, DF19FD, 1DEDBB, 5500DE,FFA9E7, 980618&07

#ALM, 20,1283,54133D, 0F0DC9,FD4100, A10C6F, 16E0FE, 41DD95,D2B291, EE002D&92

#ALM, 21,1283,554A57, 0F067A,FD4100, A10D07, EE6B06, 7C6B50, 24326A, 0A000B&42

#WTP, 1282,467140.291,3912413, -78916,5020026, &D2

#EPH, 16,409000,191EA0,D180AF, B1A11B, D70FEB, B07242, 00FFFB, 01056B,B0FC55, 2F6C60,CEB392, FCE001, 4ACF8D, 1445A1, 0CAE29, 72427F, 00039C, 200047,000627,2B6F6E, 1819C8, 529753,FFA9D7, B0FCD3&A8

#ALM, 22,1283,5627B5, 0F0C16,FD4000, A10D03, 1967D9,C39FBE, 9F16BE, 020007&5C

#ALM, 23,1283,571E8D, 0F0BE4,FD5000, A10DB5, 41C23B, 552133,97BE38, 120074&42

#WTP, 1282,467141.315,3912413, -78916,5020026, &D0

#EPH, 17,409000,191EA0,D180AF, B1A11B, D70FFD, B47241, 00FF92,F0B418, B4FF4C, 342DAB, 86653B,FF3C08, CFB404, 09ADA1, 0D2FCE, 724117,0054F6, 4270E1,FF6A27, 6F480E, 24AD8F,C5200D, FFA5C4, B400CF&14

#ALM, 24,1283,584D70, 0F115B,FD4F00, A10D20, EE8BD9, C729AF, 2413DD, 060029&7D

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#EPH, 20,409001,191EA0,D180AF, B1A11B, D70FF1, 8D7242, 000020,EE3A42, 8DFC4E, 302338,979E6A,FC5901, 34559B, 118BA1, 0CDA02, 72427D,FFE51B, D9E55F, FFEF27, 4328C4, 1B5441,D2650C, FFA85E, 8DF4D2&DE

#ALM, 26,1283,5A7FAC, 0F1A1E,FD6300, A10D2F, 425700,196253,685883,18008E&46

#ALM, 27,1283,5B95C2, 0F0530,FD4900, A10D44, 6A373F,A8A532, FC1029, 2E00B3&55

#WTP, 1282,467143.363,3912414, -78915,5020027, &D6

#EPH, 23,409000,191EA0,D180AF, B1A11B, D70FED, 077242,000060,124D1E, 070277,308AFD,DDAE47, 01FB01,E8E9D6, 10CBA1, 0E2EB4, 724279,FFCE46, BAE11B, FFBA27, 2454FE, 1C8554,F6CD2E, FFA7BD, 070592&FE

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#WTP, 1282,467144.387,3912414, -78915,5020027, &DD

#EPH, 24,409000,191EA0,D180AF, B1A11B, D70FFD, 797241,00001A, 0639AF, 7900CE, 33F689,E735BA, 010304,D62923, 092DA1, 0D77A1, 724120,0041F3, 849D01, 005127,7C25BE, 2539C7, 26812C,FFA692, 79FC34&E6

#ALM, 30,1283,5E3DD5, 0F006D,FD4300, A10C7A, 95D8A6, 3389C4,D0357A, 480018&63

#ALM, 31,1283,5F6302, 0FFBE7,FD4500, A10D3C, BFB770, 283629,171561,25006B&4D

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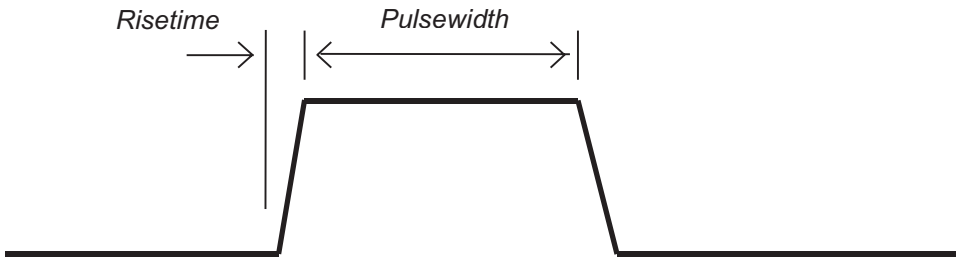
12. TIME PULSE INTERFACE

The time pulse interface outputs a precise pulse with respect to UTC time. Typically this is a 1pps signal. The time pulse is output on 1PPS port (pin 38). The signal is active high with the rising edge synchronous (+/- 30ns) to the UTC second and has a width of 100us. Alternate pulse widths may be accommodated with custom firmware. Please consult the factory.

For the 1pps to be valid the receiver must have a valid position fix and have received the UTC-GPS separation parameter downloaded from the satellite, this may take up to 12.5 minutes from a cold start.

13. FREQUENCY OUTPUT

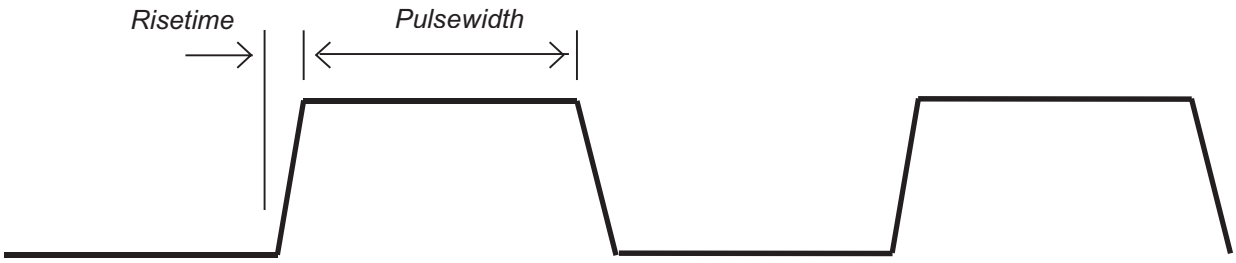


Pulse width:	100 Sec
Risetime:	maximum 10 nSec (2 metre std. lead)
Synch. to UTC:	rising edge +/- 30 nSec (GDOP, 3.0, no S/A)
Output:	+ 3.3V Volt nominal (V_{high} > 3.0 v at 6mA out, V_{low} < 0.33 v at 6mA sink)

The Wi125 is capable of producing a user select frequency.

The frequency is output on GPIO [0] port (pin 39). The frequency is configured using the FRQD command as detailed in section 8.3.10.

The frequency is only valid when the receiver has a valid 2D position fix or better.



Pulse width:	25ns minimum (CW25-NAV) 16.67ns minimum (CW25-TIM)
Duty Cycle:	50:50
Risetime:	maximum 10 ns (2 meter std. lead)
Output:	+ 3.3V Volt nominal (V_{high} > 3.0 v at 6mA out) V_{low} < 0.33 v at 6mA sink)

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14. APPLICATION HINTS

The following are a list of application hints that may help in implementing system based on the Wi125.

14.1 Power Supply

The power supply requirements of the Wi125 MCM can all be provided from a single 3.3V supply. To simplify system integration on-board regulators provide the correct voltage levels for the RF and oscillator (2.9V or 3.0V) and low voltage digital core (1.8V). In power sensitive applications it is recommended that the DIG_1V8 supply is provided from a high efficiency external 1.8V source e.g. switch mode power supply, rather than the on-board linear regulator.

If the source impedance of the power supply to the Wi125 is high due to long tracks, filtering or other causes, local decoupling of the supply signals may be necessary. Care should be taken to ensure that the maximum supply ripple at the pins of the Wi125 is 50mV peak to peak.

14.2 RF Connection

The RF connection to the Wi125 can be done in two ways. The preferred method is to use standard microstrip design techniques to track from the antenna element to the RF_IN castellation,. This also allows the systems integrator the option of designing in external connectors suitable for the application. The user can easily fit an externally mounted MCX, SMA or similar connector, provided it is placed adjacent to the RF_IN castellation. If the tracking guidelines given below are followed, the impedance match will be acceptable. The diagram below shows how this could be achieved. In this diagram, the center via of the RF connector is presumed to be plated through with a minimal pad top and bottom. The PCB material is assumed to be 1.6mm thick FR4 with a dielectric constant of 4.3. Two situations are considered; one with no ground plane and one with a ground plane on the bottom of the board, underneath the RF connector. In both cases there is no inner layer tracking under the RF connector.

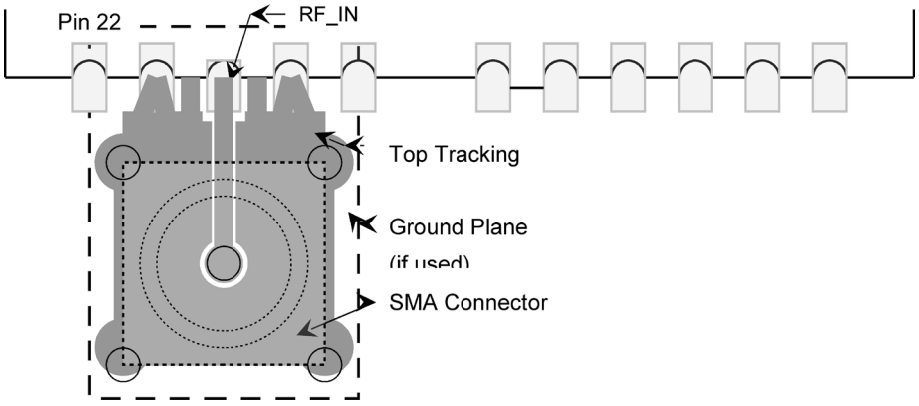

Figure 7 RF Tracking Examples

The widths of the RF_IN track and the associated gaps are given in the table below.

Scenario	Track Width (1/1000 Inch)	Gap Width (1/1000 Inch)
Without ground plane	37	6
	56	8
With ground plane	32	6
	43	8

Table 7 RF Track & Gap Widths

Alternatively, the user can attach the antenna to the Hirose H.FL-R-SMT using a flying lead fitted with a suitable plug.

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14.3 Grounding

In connecting the Wi125 into a host system, good grounding practices should be observed. Specifically, ground currents from the rest of the system hosting the Wi125 should not pass through the ground connections to the Wi125. This is most easily ensured by using a single point attachment for the ground. There must also be a good connection between the RF_GND and the DIG_GND signals. While there is not a specific need to put a ground plane under the Wi125, high energy signals should not be tracked under the Wi125. It is recommended that a ground plane be used under the Wi125. In this case, the following would be an example of the pattern that may be used.

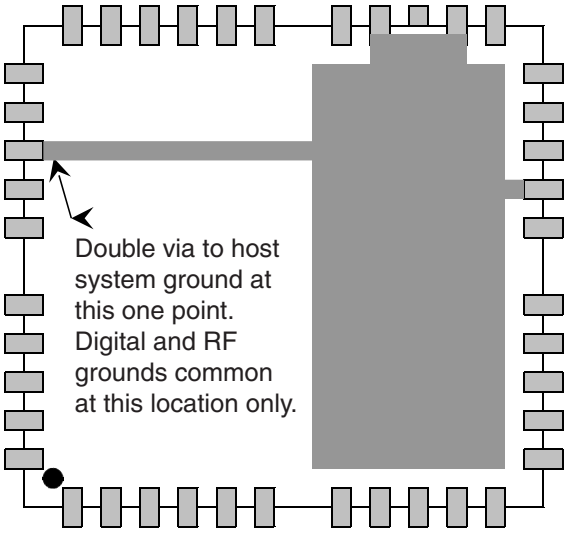

Figure 8 Grounding the Wi125 with a ground plane

14.4 Battery Backup

The Wi125 has an on-board real time clock (RTC). This is used to store date and time information while the Wi125 is powered down. Having a valid date and time speeds the time to first fix (TTFF), allowing the Wi125 to meet its quoted TTFF specification. The Wi125 relies on an external power source to power the RTC (VBATT) when the DIG_3V3 is not present. If the user application does not require the warm or hot fix performance, or the required information is provided by network assistance, there is no need to provide the VBATT signal. The VBATT signal must be greater than 2.6V and less than DIG_3V3 + 0.6V. Typically, a 3V lithium primary cell or a high capacity “supercap” will be used. The Wi125 has an internal blocking diode, so if a “supercap” or rechargeable battery is used, an external charging circuit will be required.

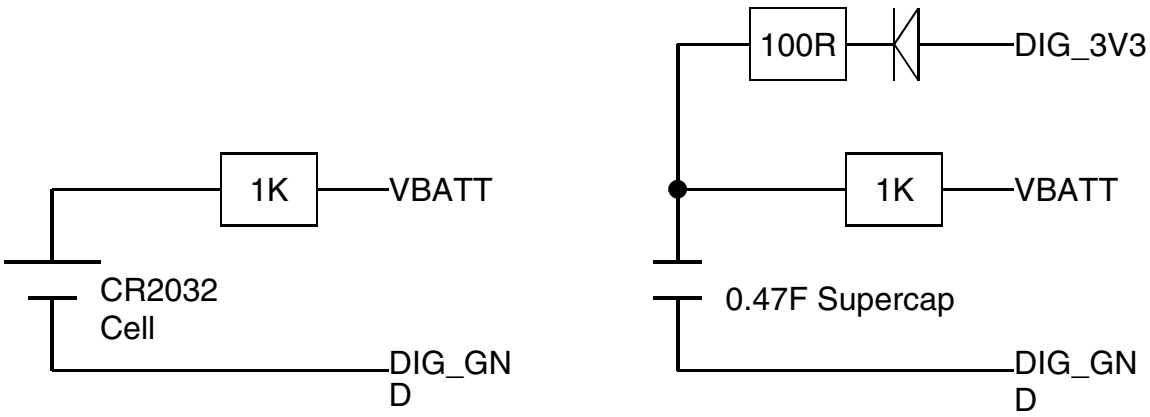

Figure 9 Typical VBATT Supplies

The 1K resistor is recommended at it limits current in the VBATT circuit and provides an easy way to measure the current in the VBATT signal. The 100R limits the inrush current into the “supercap”.

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14.5 Over Voltage & Reverse Polarity Protection

The Wi125 contains no over voltage or reverse polarity protection. The Wi125 should be handled as a CMOS component, with full anti-static handling precautions. Any fault condition that results in the maximum limits being exceeded may irreparably damage the Wi125.

14.6 Reset Generation

The power on reset for the Wi125 is generated on-board. It is generated by the regulator for the RF section. This signal is an active low, open collector signal and is presented on the NPOR castellation. If it is desired to extend the power on reset signal or provide a manual reset for the Wi125, this signal can be driven from an open collector source at any time. The nPOR signal of the NS3000IC, to which the NPOR castellation is connected, has a Schmitt trigger input. This means that there are no constraints on the rise time of the NPOR signal.

There is a second reset signal on the Wi125, the NRESET signal. NRESET is also an active low open collector signal. This signal is generated by the NS3000IC in response to the NPOR signal. It can also be generated under software control. Asserting the NRESET signal from an external open collector source will reset the ARM9 in the NS3000IC without resetting the whole chip. Generally, this signal will be left open.

14.7 Boot Options

The Wi125 has two boot modes. These are selected by the state of the BOOTSEL signal when the NPOR signal goes inactive (high). Normally, BOOTSEL is left open so that a pull-up bias in the NS3000IC will keep that signal high. When BOOTSEL is high, the Wi125 boots from the FLASH that is internal to the NS3000IC. If BOOTSEL is tied low, the Wi125 boots from the ROM internal to the NS3000IC. This ROM has a boot loader that polls the serial ports and I^2C bus for boot code. This mode of operation requires special user handling and should only be used in conjunction with specific application notes.

14.7.1 Flash Programming

The Wi125 contains 128k Flash memory internal to the BB25IC which hold the module firmware. The Flash is re programmable in the field by means of a ROM boot loader utility. To run the boot loader the unit must be powered up with the BSEL line set to the correct state. A loader program and batch file are provided to transfer the firmware binary image file to the module. To reprogram the module follow the instructions below:

1) With the module powered down, connect the BSEL pin to GND
2) Connect any of the Wi125 serial ports to COM1 of your PC.
3) Power the unit up. The Wi125 should start by outputting a stream of 'Z' characters at 38400 baud. You might like to check this out via a terminal program. If after about 20 seconds the re-programming step (4) hasn't started, the stream of 'Z"s will stop and the existing Wi125 firmware will run.
4) Just after the unit has been powered, and while the 'Z"s are being, run "download.bat" batch file from a Console window. You can edit this batch file to use a PC port other than COM1 if you prefer. You should see:

Wi125 FILE Up/DownLoader ver 1.0
<C> NavSync Inc 2003
loader - loader.hex
baud_rate - 38400
comm - com1
Addr - 0x060000
binary file - Wi125.bin
debug_mode - 2
Reset the board and then ENTER key

5) Hit <Enter> and you will see:

Start waiting for BootRom

Then after a few seconds you should then see:

BootRom loader found

After about 7-10 seconds you should see

S-Record loader sent

Then you will see a stream of dots going across the screen as the firmware is being downloaded. Once the download has finished you will see:

Image download Passed

Process finished

If errors are encountered during the upgrade procedure simply reset the module and start the procedure again.

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APPENDIX 1

Glossary

2D	Two-dimensional
3D	Three dimensional (i.e. including altitude)
AGC	Automatic Gain Control
Almanac	Data transmitted by each satellite, and which provides the approximate orbital information of all the GPS satellites constellation (i.e. a 'timetable').
Antenna	Also called 'Aerial', the device for receiving the radio signals.
ASCII	A standard digital format for alpha-numeric characters (American Standard Code for Information Interchange).
Baud	Serial digital communication speed units (bits per second).
BIT	Built in Test
CDU	Control-Display Unit
CEP	Circular Error Probability
Channel	The satellite tracking unit of a GPS receiver. One channel may track more than one satellite, by multiplexing, but for best performance each satellite should be continuously tracked by a dedicated channel so more than one channel is often integrated into a receiver.
CMOS	A type of semiconductor fabrication process (Complementary Metal Oxide Semiconductor), resulting in low power. CMOS devices require static protection during handling.
C/No	Carrier to Noise ratio (a measure of signal quality)
COM Port	Communication port, e.g. PC serial communication ports COM1 etc.
CONUS	Continental United States
CPU	Central Processing Unit (usually the microprocessor)
CTS	Clear to Send (serial communication handshaking)
Datum	The reference shape of the Earth's surface used in the construction of a map or chart. Usually chosen for a 'best fit' over the area of interest and thus the Datum for various parts of the world may differ.
Delta range	Small changes in range between a satellite and the receiving antenna.
DoD	U.S. Department of Defense.
DOS	Disk Operating System.
DOP	A DOP (Dilution of Position) is a figure which represents the purely geometrical contribution of the satellites' positions to the total position error budget. Low values of a DOP (1 - 5) mean that the calculated position should be good whilst higher DOP values indicate a greater uncertainty in the determined position. Good DOP values are obtained when satellites are well spaced geometrically, whilst poor values result from available satellites all being visible in similar directions. When the DOP value is excessive (e.g. > 100) then neither stand-alone nor differential positions should be used.
DR	Dead Reckoning - a means of estimating present position based on a known starting position updated by applying distance and direction of the user's movements.
DSR	Data Set Ready (serial communication handshaking)
DTR	Data Terminal Ready (serial communication handshaking)
ECEF	Earth Centered Earth Fixed.
Ellipsoidal	Height as defined from the Earth's centre by a reference
Height	ellipsoid model (see Datum)
EMI/EMS/EMC	Electromagnetic Interference (emitted from equipment), Susceptibility (to interference from other equipment), and Compatibility (EMI + EMS)
EPS	Emergency Power Supply, only for maintaining the RTC data in the RAM when the equipment is powered down
ENU	East North Up (the order of listing coordinates)
Ephemeris	Similar to Almanac, but providing very accurate orbital data of each individual satellite and transmitted by the satellite concerned

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Glossary continued…

Firmware	Program resident within the receiver.
GDOP	Geometrical Dilution of Precision
Geoid	The Mean Sea Level surface of the Earth
Geoid/Ellipsoid	Difference between the Mean Sea Level and the separation mathematical model used to define a datum, at the point of interest
GHz	Gigahertz, one thousand MHz (i.e. 10^9 Hz)
GMT	Greenwich Mean Time (similar to UTC)
GPS	Global Positioning System
GPS time	Time standard for the GPS system (seconds are synchronous with UTC)
Hex	Denotes a number in hexadecimal format.
HDOP	Horizontal Dilution of Precision.
IC	Integrated Circuit.
ICD	Interface Control Document
I/O	Input - Output
IODE	Issue of Data Ephemeris
IRQ	Interrupt Request
Kalman Filter	Mathematical process used to smooth out measurement errors of pseudo-ranges and carrier phases of tracked satellites. For example '8 states' refers to filtering of position and time (i.e. x, y, z and t) and the rate of change of each.
knot	Nautical mile per hour
L1	The 1575.42 MHz frequency radiated by GPS satellites.
L-band	The band of radio frequencies between 1 and 2 GHz.
Lithium	A metallic element (used in batteries)
LMT	Local Mean Time.
mA	Milliamp (of current)
Macro	Text containing frequently used operations which can be executed as a single command (DM only).
MHz	Megahertz, i.e. one million cycles per second.
mph	Miles per Hour.
MSL	Mean Sea Level = geoidal height = 0
MIL-STD	Military Standard
Multiplexing	A receiver channel can track multiple satellites by switching rapidly between them so as to gather all data transmissions
NMEA	National Marine Electronics Association.
NMEA 0183	A serial communication standard defining hardware compatibility, message formats, and a range of standard messages.
OTF	On-The-Fly carrier phase ambiguity resolution. The ability to resolve integer carrier phase ambiguities in real-time while moving.
n.mile	International Nautical Mile (1852 metres; 6076.1 feet, 1.15 statute miles).
ns, nSec	Nanosecond, one thousandth of a microsecond (i.e. 10^{-9} second)
PC	Personal Computer (IBM compatible)
PCB	Printed circuit Board
P-code	The Precise (or Protected) GPS code - not available to civil users.
PDOP	Position Dilution of Precision, including horizontal and vertical components.
pps, PPS	Pulse per Second, and Precise Positioning Service

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Glossary continued…

PRN	Pseudo-Random Noise code unique to each satellite's message and therefore used to identify each satellite.
Pseudo Range	The apparent measured 'straight line' distance from a satellite to the receiving antenna at any instant in time, including any errors caused by satellite clocks, receiver clocks, refraction of the radio waves, etc.
PSU	Power Supply Unit
RAM	Random Access Memory
Real Numbers	Numbers which may have decimal point and fractional component
Resolution	Smallest separation of two display elements
RF	Radio frequency
RFI	Radio Frequency Interference
RMS	Root Mean Square
RPS	Relative Positioning System
RS232	Serial communication hardware standard (+/- 12v nom.)
RS422	A serial communication hardware standard (differential)
RTCM	Radio Technical Committee for Maritime Services
RTC	Real-time Clock (maintaining approximate time when unit is off)
RTK	Real Time Kinematic
RTS	Request to Send (serial communication handshaking)
RXD	Receive Data (serial communication to Data Terminal or 'DTE' from Data Communication Equipment or DCE')
S/A	Selective Availability - imposed by the DoD to limit the GPS performance available to civil users.
SEP	Spherical Error Probability
SMA	Miniature threaded coaxial connector.
SPS	Standard precision Service
SSR	Solid State Recorder
SV	Satellite Vehicle
TNC	A standard threaded coaxial connector
TSPI	Time Space Position Information
TTL	Transistor-transistor Logic (family of digital electronic components)
TTFF	Time to First Fix
TXD	Transmit Data (serial communication from Data Terminal or 'DTE' to Data Communication Equipment or 'DCE')
us, uSec	Microsecond (u is frequently used for the Greek μ symbol denoting 'micro', one millionth part, 10^{-6})
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
UART	Universal Asynchronous Receiver-transmitter (used in serial communications)
VDOP	Vertical Dilution of Precision
WGS	World Geodetic System (a world-wide Datum, GPS works in WGS84 which has superseded WGS72)

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APPENDIX 2

Contact Details

For further details and hot-line support please contact:

North American Sales

NavSync Ltd.
2111 Comprehensive Dr, Aurora, IL 60505,
USA
Telephone: +1 (630) 236-3026
Facsimile: +1 (630) 236-3023

International Sales and Support

NavSync Ltd.
BAY 143,
Shannon Industrial Estate, Shannon, Co. Clare,
Ireland.
Telephone: +353 61 472221
Facsimile: +353 61 472226

APPENDIX 3

World Wide Web Information

There are several GPS related sites on the World Wide Web (www) that are excellent sources to obtain further information about GPS and the current status of the satellites.

U.S. Coast Guard Navigation Center

Civilian GPS service notices, general system information, and GPS outage reporting:
www.navcen.uscg.gov

U.S. Naval Observatory

General USNO information and links to USNO timing and other useful sites:
www.usno.navy.mil

NAVSYNC GPS Homepage

www.navsync.com

General GPS Information and links to other useful GPS sites:

USAF GPS Wing
www.losangeles.af.mil

National Marine Electronics Association (NMEA)

For information on the NMEA protocol specification:
www.nmea.org

General GPS Information

Glossary of GPS terms:
www.gpsworld.com/resources/glossary.htm

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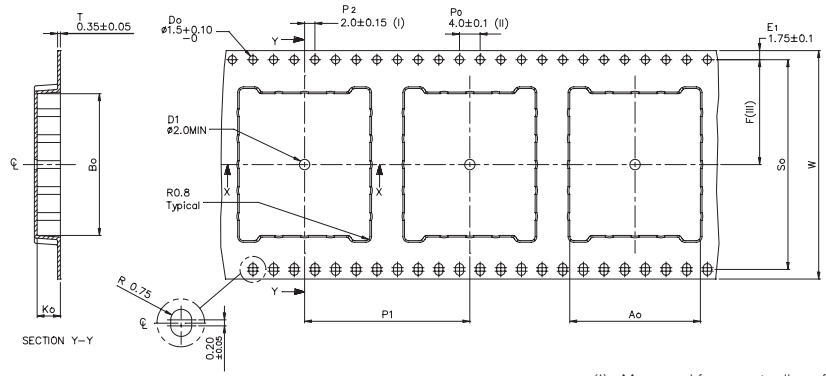
APPENDIX 4

Tape & Reel Specifications



Ao	25.30 +/− 0.1
Bo	27.30 +/− 0.1
Ko	4.50 +/− 0.1
F	20.20 +/− 0.15
P1	32.00 +/− 0.1
So	40.40 +/− 0.1
W	44.00 +/− 0.3

General Tolerance ±0.2
Drawing not to Scale

(I) Measured from center line of sprocket hole to center line of pocket.
(II) Cumulative tolerance of 10 sprocket holes is ± 0.20.
(III) Measured from center line of sprocket hole to center line of pocket.
(IV) Other material available.

ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE STATED

Figure 10 Tape and Reel

Solder Profile

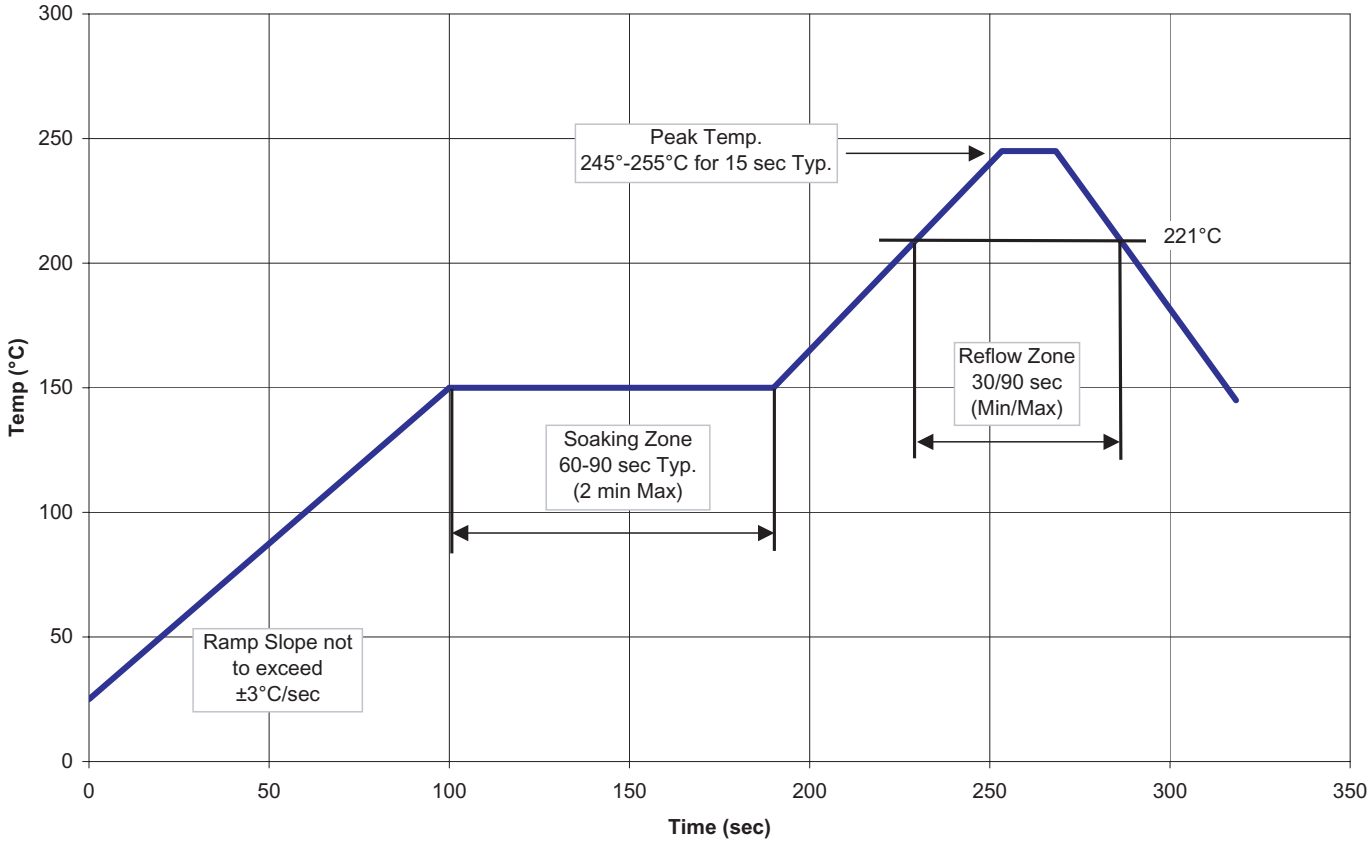


Figure 11 Solder Profile

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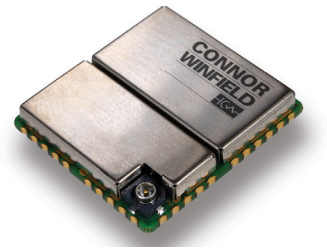
Series 125
Wi125 Receiver
User Manual

Available at Digi-Key
www.digikey.com



Revision	Revision Date	Notes
R00	07/24/09	Released
R01	04/13/10	Update to 1 PPS (timing) Accuracy Specific cation
R02	06/18/10	125 Series Updated
R03	10/20/11	Update to 1PPS (timing) Accuracy Specification